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THE MECHANICAL PROPERTY DATA BASE FROM AN
AIR FORCE/INDUSTRY COOPERATIVE TEST PROGRAM ON ADVANCED ALUMINUM
ALLOYS (2091 SHEET, PLATE, AND 8090 EXTRUSION)

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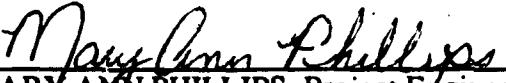
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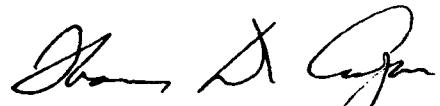
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PREFACE

This report was prepared by the Materials Engineering Branch (WL/MLSE), Systems Support Division, Materials Directorate, Wright Laboratory, Wright-Patterson Air Force Base, Ohio, under Project 2418, "Metallic Structural Materials," Task 241807, "Systems Support," Work Unit 24180703, "Engineering and Design Data."

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PREFACE

This report was prepared by the Materials Engineering Branch (WL/MLSE), Systems Support Division, Materials Directorate, Wright Laboratory, Wright-Patterson Air Force Base, Ohio, under Project 2418, "Metallic Structural Materials," Task 241807, "Systems Support," Work Unit 24180703, "Engineering and Design Data."

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SECTION 1

INTRODUCTION

High performance aerospace systems are dependent on materials that are lighter, have improved mechanical properties, and/or offer a cost savings. Aluminum alloys that met these criteria were the newly developed aluminum-lithium alloys and the second generation powder metallurgy alloys.

In 1985, the Air Force along with the aerospace community found it important to investigate the potential of these promising aluminum alloys. A cooperative program was formed by the Wright Laboratory Materials Directorate, Systems Support Division, and a number of aerospace industries. The Air Force would obtain the test material from the producers, compile the test data, and submit reports to the participants. The participants agreed to support the program by performing mechanical property tests which include tension, compression, bearing, shear, fracture toughness, and fatigue related properties (S/N, da/dn). The Air Force elected to perform spectrum fatigue crack growth testing on most alloys. A list of participants is shown in the following table.

This Interim report contains the aluminum-lithium alloys produced by Alcoa 2091 0.063 inch thick sheet, 2091 0.144 inch thick sheet, 2091 0.5 inch plate, 8090 hat extrusion and 8090 L extrusion. Comparisons to other materials and ranking of materials are generally avoided since each potential application may be based on different evaluation criteria.

TABLE
PARTICIPANTS AND ADVANCED ALUMINUM ALLOYS
in the COOPERATIVE TEST PROGRAM

ALUMINUM LITHIUM ALLOYS								P/M ALUMINUM ALLOYS	
PARTICIPANTS	PECHINEY	ALCAN	INCOMAP	ALCOA	REYNOLDS	KAIER	ALCOA		
Air Force WPAFB, OH	x	2091-T3 Sheet (0.063") 2091-T3S1 Plate (0.420") 2091-T6 Forging 8090-T6S1 Extrusion	x	PM W905XL Forging 8090-T871 Plate (1.75")	x	x	x	7084-T74S1 Extrusion	
Army, MA								x	
AVCO, TN								x	
Boeing, WA	x x x x					x	x		
Douglas Aircraft, CA			x	x	x	x	x		
General Dynamics, CA	x x		x	x	x	x	x		
General Dynamics, TX	x x x x	x	x	x	x	x	x		
Grumman Aerospace, NY	x x	x	x	x	x	x	x		
Jet Propulsion, CA			x	x	x	x	x		
Lockheed, CA	x	x	x	x	x	x	x		
Lockheed, GA	x	x	x	x	x	x	x		
LTV, TX	x	x	x	x	x	x	x		
Martin Marietta, LA	x x x x	x x	x x	x x	x x	x x	x x		
McDonnell Douglas Astro, CA				x	x	x	x		
McDonnell Douglas Helicopter, AR			x	x	x	x	x		
McDonnell Douglas Missile Sys, MO				x	x	x	x		
McDonnell Aircraft, MO	x		x	x	x	x	x		
NASA, VA		x	x	x	x	x	x		
Naval Air Development Center	x	x	x	x	x	x	x		
Northrop, CA	x x x	x x	x x	x x	x x	x x	x x		
Sikorsky, CT			x	x	x	x	x		
Sundstrand, IL				x	x	x	x		
Wyman-Gordon				x	x	x	x		

SECTION 2

MATERIALS AND TESTS

The Alcoa aluminum-lithium alloys were received on various dates: 2091-T3 0.063-inch sheet October 1988, 2091-T3 0.144-inch sheet March 1988, 2091-T8 0.5-inch plate March 1989, and 8090-T8 hat extrusion and 8090-T8 L extrusion September 1991. The 2091 was developed for maximum damage tolerance and 8090 for damage tolerance and higher strength.

The 2091-T3 0.063-inch sheet was tested as received by the Air Force and Martin Marietta. However, Northrop and McDonnell aircraft Company heat treated the alloy to a T8 condition. The 2091-T3 0.144-inch sheet was tested as received by the Air Force, Martin Marietta and McDonnell Douglas Astronautics. However, General Dynamics aged their material at 16 and 32 hours at 335°F and Northrop heat treated their material to a T8X temper. The 2091-T8 0.5-inch plate was tested as received. The dimensions of the 8090-T8 hat and L-extrusion are shown in Appendix M Figure M1 and Figure M2 respectively. The L-extrusion had to be cut for achieving the T8 condition making a thin and a thick piece. The L-extrusion was received in two pieces (0.60" x 4.00" x length and 1.55" x 1.55" x length).

Mechanical properties, (tension, compression, bearing, shear, and fracture toughness) fatigue and constant amplitude fatigue crack growth tests were tested according to ASTM standards, unless otherwise specified.

Spectrum tests were performed by the Air Force using FALSTAFF (a severe fatigue environment) and Mini-TWIST (a moderately intense fatigue environment) spectrums.

SECTION 3

PRESENTATION

Each participant compiled a data package which contained the data they generated. Some of these data packages contained discussions and in other cases, only the data were provided. The tensile, compression, bearing, and shear are put in tabular form. Fracture toughness, fatigue, fatigue crack growth, and spectrum fatigue crack growth data were placed in tabular and graphical form.

SECTION 4

RESULTS AND DISCUSSION

The data generated by the participants on the 2091 sheet, plate, and 8090 extrusions are in the Appendices. The following table lists the aluminum-lithium alloy, form, and the appendix in which the data can be found.

**Table
Contents of Appendices**

Aluminum-Lithium Alloy	Form	Appendix
2091-T3	0.063" Sheet	J
2091-T8	0.063" Sheet	J
2091-T3	0.144" Sheet	K
2091-T8	0.144" Sheet	K
2091-T8	0.500" Plate	L
8090-T8	Hat Extrusion	M
8090-T8	L-Extrusion	M

SECTION 5

CONCLUSIONS

Seven aerospace laboratories participated in generating data on the 2091 sheet, plate, and 8090 extrusions for the cooperative test program. These data combined with previous interim reports on the Air Force/Industry Cooperative Test Program on Advanced Aluminum Alloys provide an extensive data base on aluminum-lithium alloys.

APPENDIX J

**2091-T3 and 2091-T8
0.063-Inch Sheet**

TABLE J1
TENSILE RESULTS FOR ALCOA
2091-T3 SHEET (0.063" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION (DEGREES F)	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	E LONG (%)	RA (%)	E (MSI)		
MARTIN MARIETTA, LOUISIANA	RT	LONG	62.5	48.1	19.0	23.0	10.8		
			61.1	47.0	19.5	23.0	10.6		
			61.7	47.5	21.0	23.0	10.1		
AIR FORCE	RT	LONG	60.8	47.6	22.4	24.8			
			60.7	47.6	25.1	23.1			
			60.4	47.5	22.9	23.1			
AVERAGE			61.2	47.6	21.7	23.3	10.5		
STANDARD DEVIATION			0.8	0.4	1.0	0.3	0.4		

TABLE J2
TENSILE RESULTS FOR ALCOA
2091-T3 SHEET (0.063" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION (DEGREES F)	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	E LONG (%)	RA (%)	E (MSI)		
AIR FORCE	RT	45	60.6	40.4	23.4	27.3			
			60.6	40.4	22.9	25.3			
			60.8	41.1	21.8	26.4			
AVERAGE			60.7	40.6	22.7	26.3			
STANDARD DEVIATION			0.1	0.4	0.8	1.0			

TABLE J3
TENSILE RESULTS FOR ALCOA
2091-T3 SHEET (0.063" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
AIR FORCE	RT	60	62.4	41.9	23.6	24.5	
			60.5	39.7	20.4	25.1	
			60.5		22.1	26.2	
		AVERAGE	61.1	40.8	22.0	25.3	
		STANDARD DEVIATION	1.1	1.6	1.6	0.9	

TABLE J4
TENSILE RESULTS FOR ALCOA
2091-T3 SHEET (0.063" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
MARTIN MARIETTA, LOUISIANA	RT	L TRANS	65.0	43.2	11.0	19.0	10.4
			65.8	44.5	19.0	19.0	10.9
			65.5	42.7	17.0	19.0	8.9
AIR FORCE	RT	L TRANS	63.9	42.7	17.1	20.7	
			63.5	42.1	17.9	21.4	
			64.2	43.7	19.0	21.2	
		AVERAGE	64.7	43.2	16.8	20.1	10.1
		STANDARD DEVIATION	0.9	0.9	3.0	1.2	1.0

R-CURVE FOR 2091-T3, .063 inch SHEET
(longitudinal)

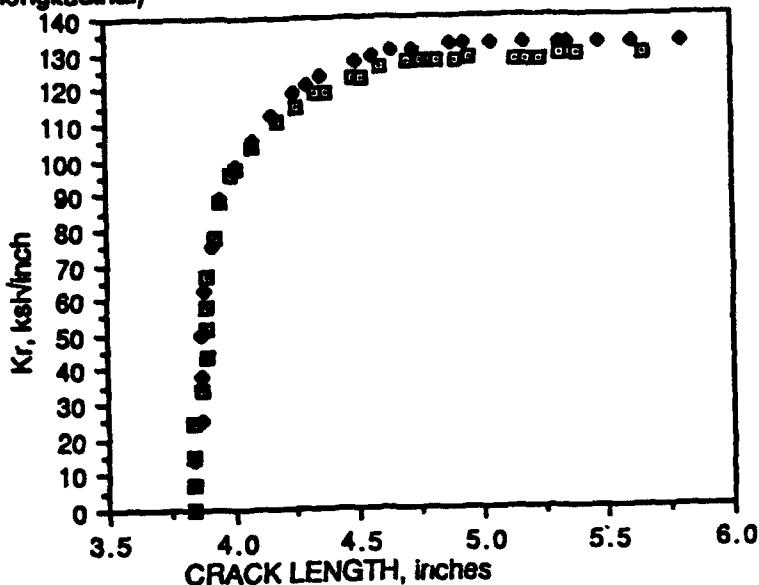


Figure J1. R-Curve Results for 2091-T3 0.063 inch Sheet
(L-T Orientation).
Martin Marietta.

R-CURVE FOR 2091-T3, .063 inch SHEET
(transverse)

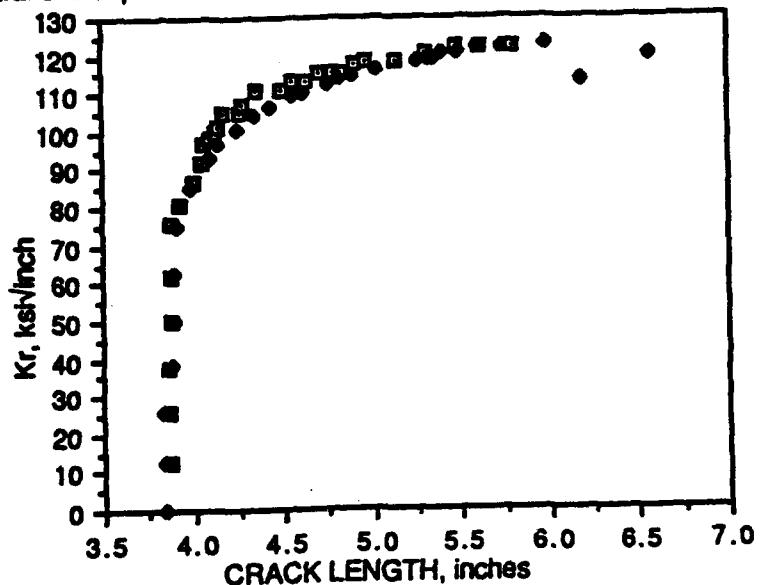
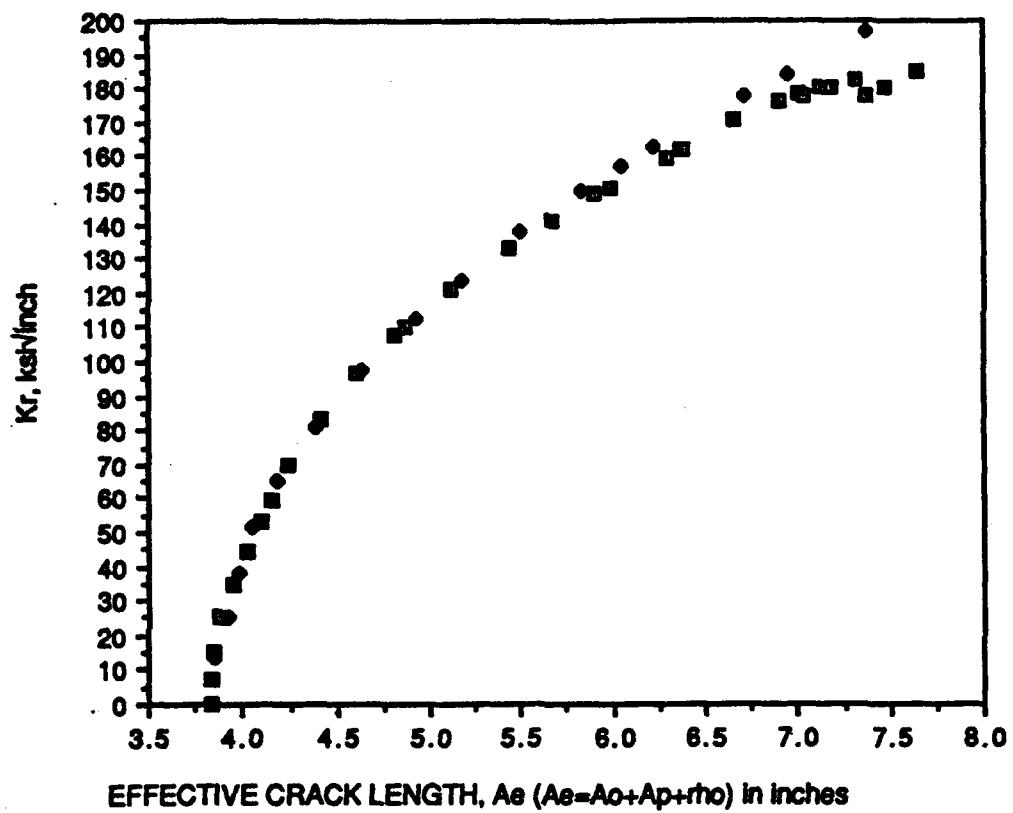


Figure J2. R-Curve Results for 2091-T3 0.063 inch Sheet
(T-L Orientation).
Martin Marietta.

**R-CURVE FOR 2091, .063 inch Sheet
(longitudinal)
(effective crack length adjusted for plastic zone)**



**Figure J3. R-Curve Results for 2091-T3 0.063 Inch Sheet,
with Effective Crack Length Adjusted for
Plastic Zone (L-T Orientation).
Martin Marietta.**

R-CURVE FOR 2091-T3, .063 inch SHEET
(transverse)
(effective crack length adjusted for plastic zone)

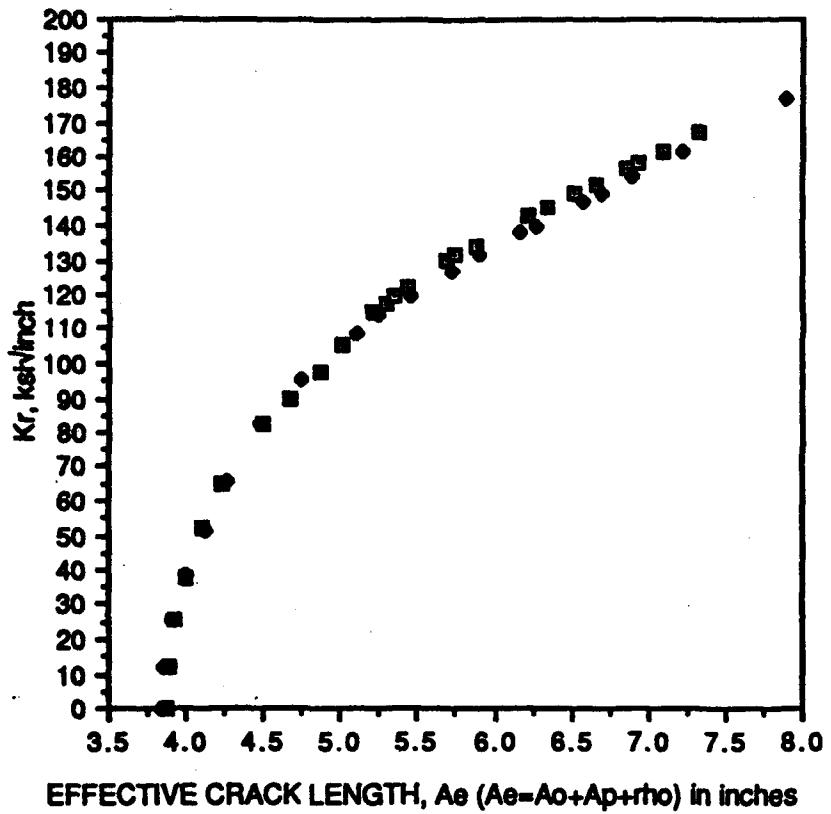


Figure J4. R-Curve Results for 2091-T3 0.063 Inch Sheet,
with Effective Crack Length Adjusted for
Plastic Zone. (T-L Orientation).
Martin Marietta.

TABLE J5
R-Curve Data Associated with Figures J1 and J3

DATA FOR SPECIMEN NO. 1

2091-T3 LONGITUDINAL SHEET

Load, kips	Half Crack Length (a), inch	Half Crack Length (a + rho), inch	Corresponding Fracture Toughness, ksi/inch	
			Not Adjusted	Adjusted for Plasticity
0	3.835	3.835	0.0	0.0
3.0	3.835	3.838	7.4	6.9
6.1	3.835	3.851	15.0	15.1
10.1	3.835	3.879	24.9	25.1
13.8	3.870	3.955	34.2	34.6
17.4	3.890	4.027	43.3	44.1
20.8	3.895	4.095	51.8	53.2
23.1	3.900	4.150	57.5	59.5
26.7	3.900	4.241	66.5	69.6
30.9	3.925	4.416	77.3	83.5
34.9	3.950	4.613	87.7	97.0
37.7	3.995	4.813	95.5	107.7
38.3	4.015	4.873	97.3	110.3
40.4	4.080	5.113	103.7	121.3
42.5	4.180	5.437	110.9	133.5
43.4	4.255	5.667	114.6	141.5
44.3	4.330	5.902	118.4	149.3
44.3	4.375	5.985	118.4	151.1
44.7	4.490	6.293	122.4	159.9
44.8	4.515	6.362	122.4	161.8
44.8	4.525	6.384	122.4	162.3
45.2	4.600	6.661	125.9	170.9
44.9	4.710	6.908	127.2	176.5
44.7	4.765	7.013	127.2	178.5
44.3	4.810	7.034	127.2	177.5
44.3	4.830	7.120	127.2	180.2
43.8	4.900	7.186	127.2	180.0
43.6	4.960	7.320	128.3	182.9
42.1	5.140	7.376	127.3	178.0
41.8	5.190	7.473	127.3	179.9
41.7	5.240	7.646	127.3	184.7
41.4	5.325		128.7	
40.9	5.385		128.7	
39.2	5.650		128.7	
35.6	6.040		123.2	

Thickness = .063 inches
Yield Strength = 47.5 ksi
Specimen Width = 23.88 inches

TABLE J6
R-Curve Data Associated with Figures J1 and J3

DATA FOR SPECIMEN NO. 2

2091-T3 LONGITUDINAL SHEET

Load, kips	Half Crack Length (a), inch	Half Crack Length (a + rho), inch	Corresponding Fracture Toughness, ksi/inch	
			Not Adjusted	Adjusted for Plasticity
0	3.835	3.835	0.0	0.0
5.7	3.835	3.847	14.1	13.2
10.2	3.875	3.921	25.3	25.5
15.2	3.875	3.978	37.8	38.3
20.1	3.875	4.060	49.9	51.2
25.2	3.885	4.185	62.7	65.2
30.1	3.920	4.382	75.3	80.9
35.1	3.955	4.630	88.3	97.8
38.7	4.020	4.921	98.4	113.0
41.0	4.085	5.172	105.4	124.1
43.3	4.160	5.501	112.7	137.9
44.9	4.245	5.825	118.4	149.7
45.5	4.305	6.042	121.1	156.9
46.0	4.355	6.225	123.4	162.8
46.5	4.495	6.723	127.5	177.7
46.5	4.560	6.951	128.8	184.1
46.5	4.635	7.376	130.3	197.1
46.0	4.730		130.3	
45.3	4.885		131.9	
44.9	4.940		131.9	
44.2	5.045		131.9	
43.4	5.175		131.9	
42.3	5.325		131.9	
42.5	5.350		131.9	
41.6	5.470		131.9	
40.4	5.610		131.9	
39.3	5.800		131.9	

Thickness = .063 inches
Yield Strength = 47.5 ksi
Specimen Width = 23.87 inches

TABLE J7
R-Curve Data Associated with Figures J2 and J4
DATA FOR SPECIMEN NO. 3
2091-T3 TRANSVERSE SHEET

Load, kips	Half Crack Length (a), inch	Half Crack Length (a + rho), inch	Corresponding Fracture <u>Toughness, ksi $\sqrt{\text{inch}}$</u>	
			Not Adjusted	Adjusted for Plasticity
0	3.875	3.875	0.0	0.0
5.1	3.875	3.887	12.7	11.8
10.3	3.875	3.931	25.6	25.8
15.0	3.880	4.001	37.3	37.9
20.2	3.880	4.105	50.2	51.8
24.8	3.880	4.230	61.6	64.5
30.1	3.925	4.494	75.4	82.3
31.9	4.000	4.673	80.9	89.5
34.0	4.055	4.861	87.0	97.9
35.8	4.070	5.015	91.8	106.0
37.7	4.105	5.214	97.2	114.8
38.1	4.135	5.293	98.7	117.4
38.6	4.145	5.354	100.2	119.9
39.0	4.175	5.439	101.7	122.6
39.8	4.260	5.684	105.2	130.1
39.9	4.290	5.748	105.2	131.7
40.0	4.360	5.883	107.4	134.6
40.4	4.500	6.226	110.9	143.2
40.4	4.555	6.338	110.9	145.6
40.4	4.640	6.519	113.3	149.5
40.2	4.710	6.660	113.3	152.3
40.2	4.790	6.856	115.4	156.7
40.1	4.830	6.934	115.4	158.2
39.8	4.910	7.099	115.4	161.3
39.8	4.975	7.318	117.5	167.4
39.2	5.140		118.6	
38.5	5.315		118.6	
37.7	5.485		120.1	
37.5	5.625		122.0	
36.5	5.810		122.0	

Thickness = .063 inches
 Yield Strength = 43.5 ksi
 Specimen Width = 23.87 inches

TABLE J8
R-CURVE DATA ASSOCIATED WITH FIGURES J2 AND J4

DATA FOR SPECIMEN NO. 4

2091-T3 TRANSVERSE SHEET

Load, kips	Half Crack Length (a), inch	Half Crack Length (a + rho), inch	Corresponding Fracture Toughness, ksi/inch	
			Not Adjusted	Adjusted for Plasticity
0.0	3.845	3.845	0.0	0.0
5.1	3.845	3.857	12.6	11.8
10.4	3.845	3.901	25.7	25.9
15.3	3.880	4.006	38.0	38.7
20.0	3.895	4.116	49.8	51.3
25.1	3.895	4.256	62.5	65.5
30.1	3.915	4.481	75.2	82.1
33.7	3.985	4.751	85.2	95.5
36.2	4.105	5.092	93.3	108.4
37.4	4.145	5.246	97.0	114.4
38.1	4.245	5.459	100.4	120.1
38.8	4.350	5.717	104.0	127.5
39.2	4.430	5.900	106.4	132.2
39.4	4.565	6.170	109.2	138.1
39.4	4.625	6.282	110.2	140.4
39.4	4.755	6.571	112.4	146.9
39.4	4.815	6.701	113.5	149.8
39.3	4.900	6.905	114.6	154.4
39.1	5.030	7.226	116.3	161.6
38.3	5.260	7.896	117.9	177.0
38.3	5.320		119.0	
38.3	5.350		119.0	
38.2	5.400		120.1	
37.7	5.495		120.1	
37.6	5.605		121.9	
36.9	5.735		121.9	
35.8	5.990		122.9	
31.9	6.185		112.8	
31.9	6.575		119.7	

Thickness = .063 inches
Yield Strength = 43.5 ksi
Specimen Width = 23.88 inches

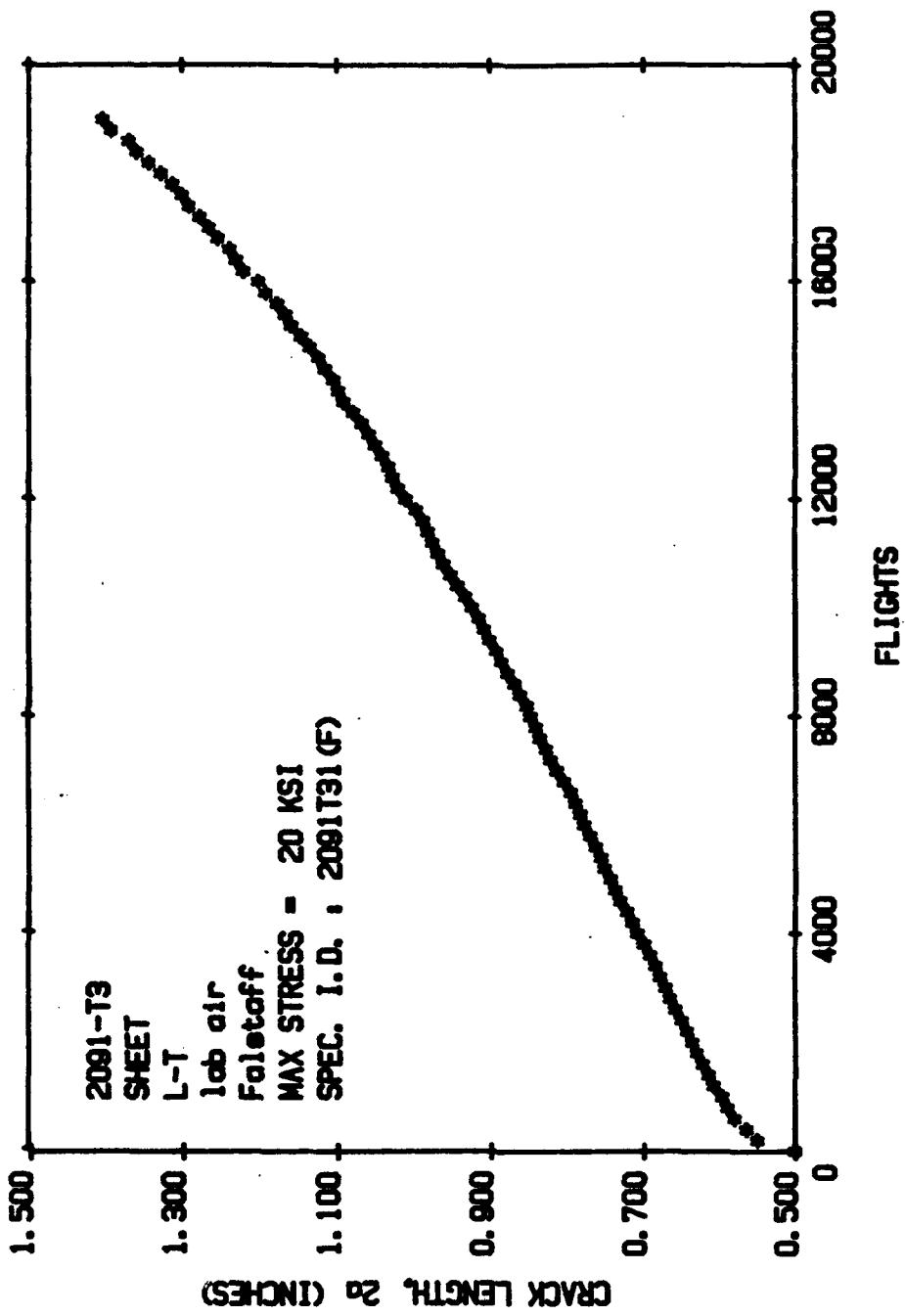


FIGURE J5.
 TALSTAFF SPECTRUM
 CRACK LENGTH VS FLIGHTS DATA FOR 2091-T3
 0.063 INCH SHEET,
 AIR FORCE.

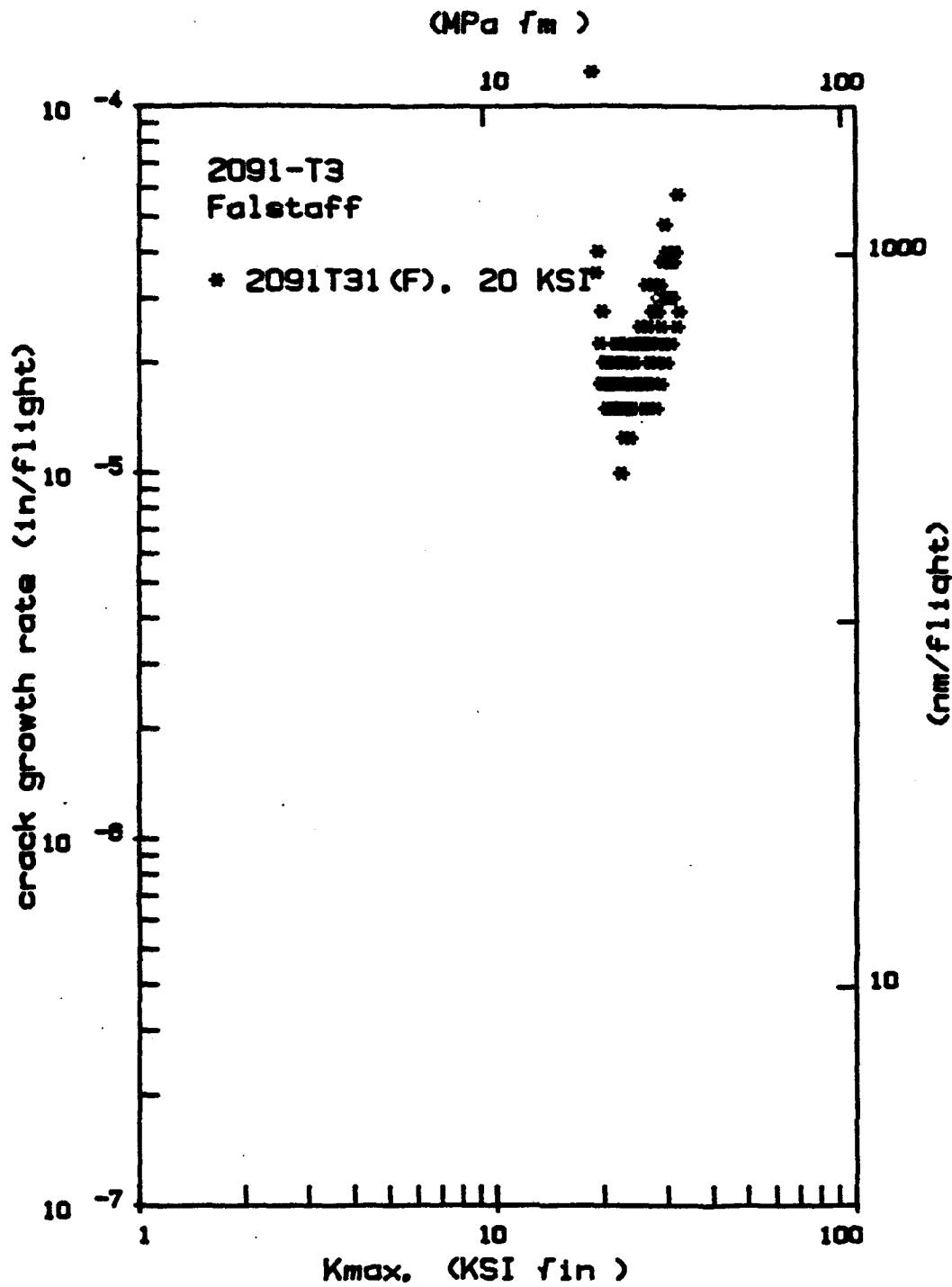


Figure J6. FALSTAFF Spectrum Crack Growth Rate vs Kmax Data for 2091-T3
0.063 Inch Sheet.
Air Force

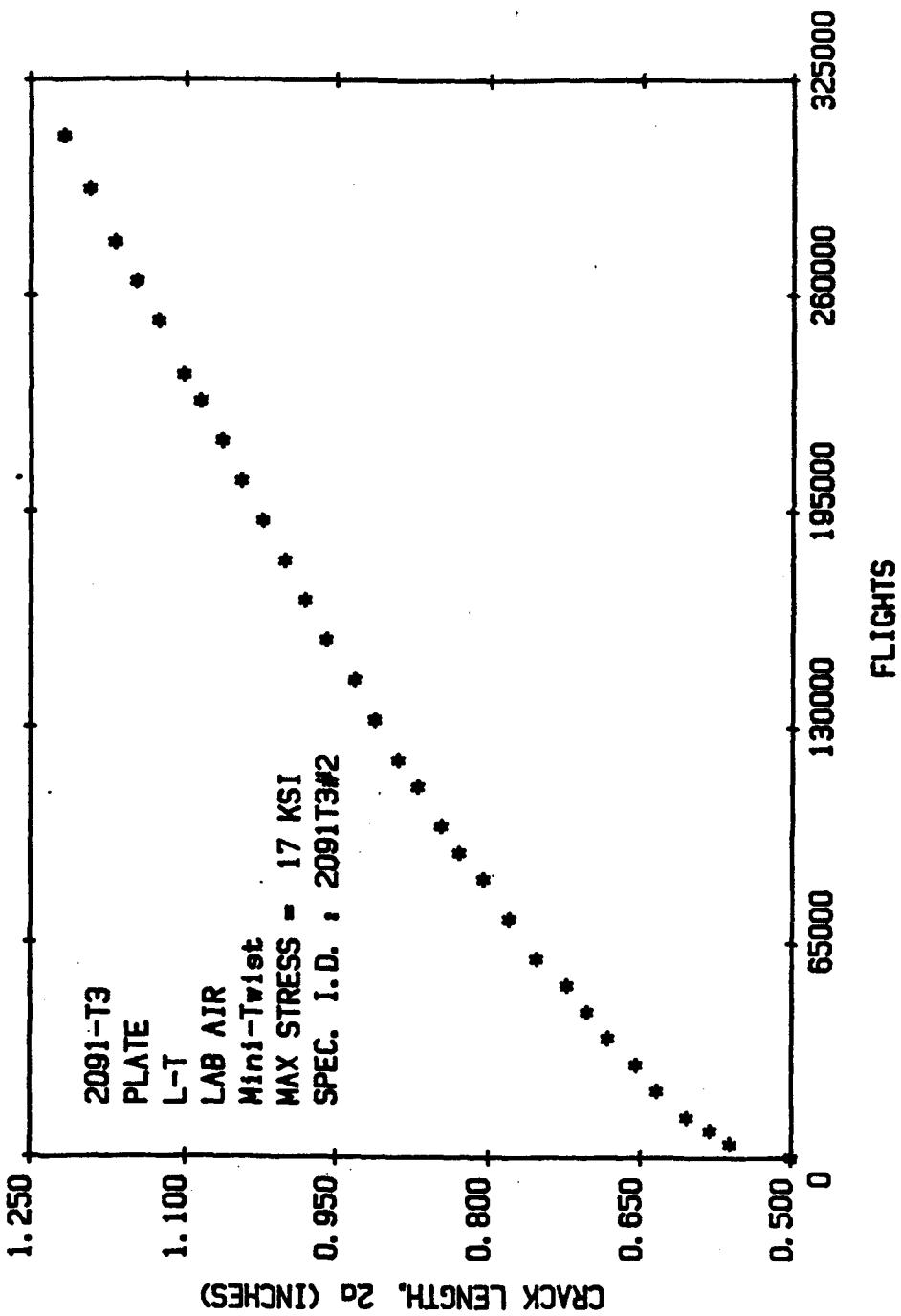


Figure J7. Mini-TWIST Spectrum Crack Length vs Flights Data for
for 2091-T3 0.063 Inch Sheet.
Air Force

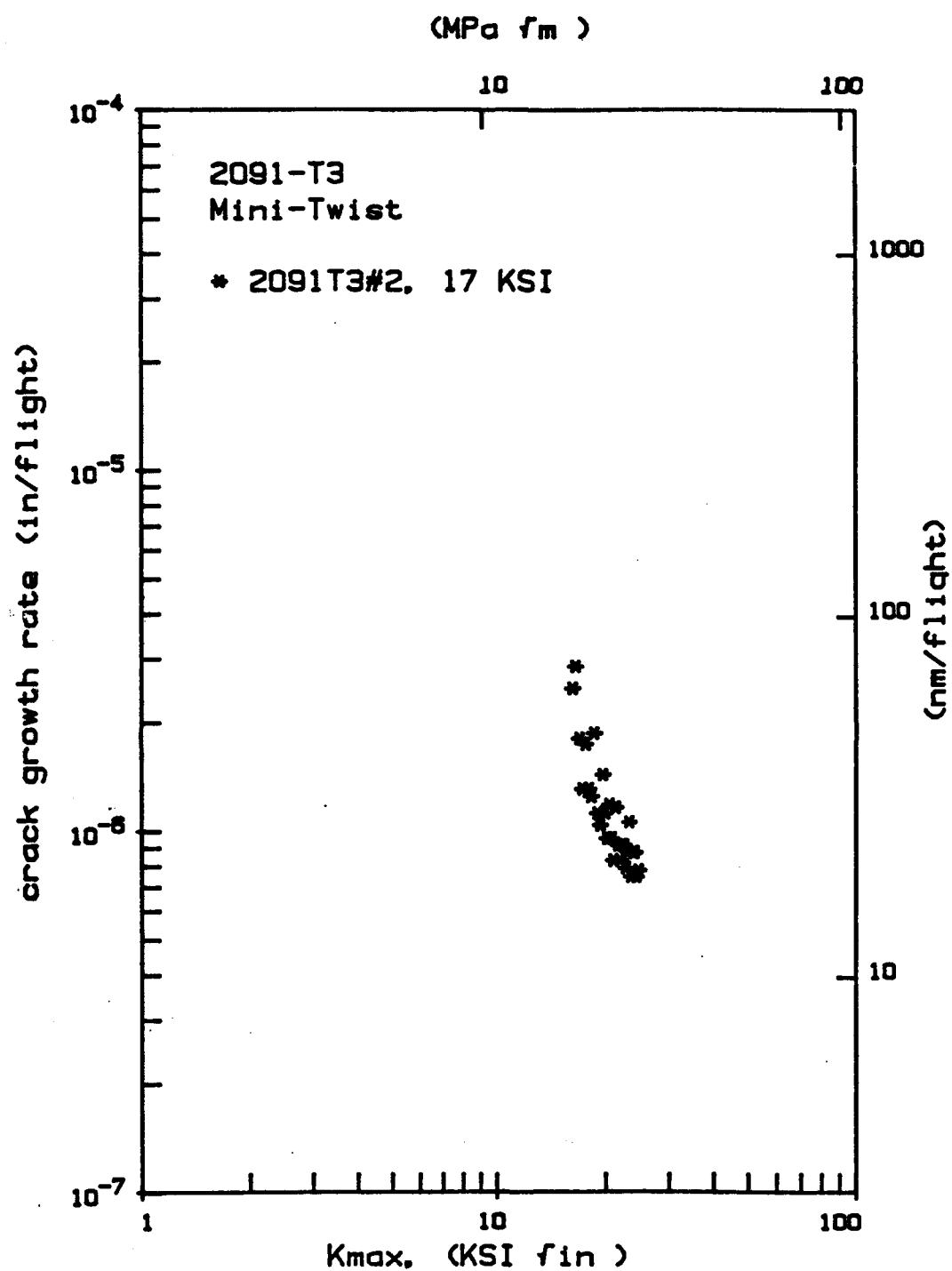


Figure J8. Mini-TWIST Spectrum Crack Growth Rate vs
Kmax Data for 2091-T3
0.063 Inch Sheet, Air Force

TABLE J9
TENSILE RESULTS FOR ALCOA
2091-T8 SHEET (0.063" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)		
MCAIR	RT	LONG	62.5	50.0	22.0		5.5		
			62.5	49.4	21.0		5.4		
			61.5	49.2	20.0		5.9		
NORTHROP	RT	LONG	65.2	53.2	21.9		11.2		
			64.9	52.9	19.0		11.2		
			64.9	53.1	21.9		11.2		
			64.7	52.9	21.9		11.3		
AVERAGE			63.7	51.5	21.1		8.8		
STANDARD DEVIATION			1.5	1.9	0.6		3.0		

TABLE J10
TENSILE RESULTS FOR ALCOA
2091-T8 SHEET (0.063" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)		
MCAIR	RT	45 DEG	62.0	38.0	24.0		6.0		
			62.0	38.5	25.0		5.9		
			62.5	38.0	22.0		6.7		
NORTHROP	RT	45 DEG	64.3	43.9	16.9		11.0		
			63.4	43.8	14.1		11.0		
			64.1	43.9	17.2		11.2		
			63.8	43.1	16.7		11.0		
AVERAGE			63.2	41.3	19.4		9.0		
STANDARD DEVIATION			1.0	3.0	4.2		2.6		

TABLE J11
TENSILE RESULTS FOR ALCOA
2091-T8 SHEET (0.063" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)		
MCAL	RT	L TRANS	64.5	40.9	18.0		5.6		
			65.0	43.6	16.0		5.9		
			66.0	42.3	21.0		5.5		
NORTHROP	RT	L TRANS	67.9	47.7	20.8		11.3		
			68.2	47.4	18.2		11.3		
			67.5	47.7	16.9		11.2		
			68.3	47.2	18.7		11.1		
AVERAGE			65.2	42.3	18.3		5.7		
STANDARD DEVIATION			0.8	1.4	2.5		0.2		

E J12

COMPRESSION RESULTS FOR ALCOA

2091-T8 SHEET (0.063" X 48" X 48")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)
MCAIR	RT	LONG		12.5
				11.5
NORTHROP	RT	LONG	41.7	11.5
			42.2	11.2
			41.7	12.1
		AVERAGE	41.9	11.8
		STANDARD DEVIATION	0.3	0.5

TABLE J13

COMPRESSION RESULTS FOR ALCOA

2091-T8 SHEET (0.063" X 48" X 48")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)
MCAIR	RT	45 DEG		12.1
				12.2
				11.7
		AVERAGE		12.0
		STANDARD DEVIATION		0.3

TABLE J14
 COMPRESSION RESULTS FOR ALCOA
 2091-T8 SHEET (0.063" X 48" X 48")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)
MCAL	RT	L TRANS	12.6	
			12.6	
			12.5	
NORTHROP	RT	L TRANS	48.4 48.8 48.9	12.1 11.9 12.0
		AVERAGE	48.7	12.3
		STANDARD DEVIATION	0.3	0.3

TABLE J15
SLOTTED SHEAR RESULTS FOR ALCOA
2091-T8 SHEET (0.063" X 48" X 48")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
MCAIR	LONG	44.8
		46.8
NORTHROP	LONG	43.9
		43.8
		43.7
	AVERAGE	44.6
	STANDARD DEVIATION	1.3

TABLE J16
SLOTTED SHEAR RESULTS FOR ALCOA
2091-T8 SHEET (0.063" X 48" X 48")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
NORTHROP	L TRANS	44.7
		45.0
		44.6
	AVERAGE	44.8
	STANDARD DEVIATION	0.2

TABLE J17
BEARING RESULTS FOR ALCOA
2091-T8 SHEET (0.063" X 48" X 48")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
MCAIR	LONG	1.5	96.1 98.9 99.2	83.5 83.9
NORTHROP	LONG	1.5	101.6 100.7 101.7	71.1 69.7 72.2
		AVERAGE	99.7	76.1
		STANDARD DEVIATION	2.1	7.0

TABLE J18
BEARING RESULTS FOR ALCOA
2091-T8 SHEET (0.063" X 48" X 48")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
MCAIR	L TRANS	1.5	98.2 97.4 97.5	85.7 84.0 85.1
NORTHROP	L TRANS	1.5	104.4 103.7 104.0	76.9 73.9 75.4
		AVERAGE	100.9	80.2
		STANDARD DEVIATION	3.5	5.3

TABLE J19
BEARING RESULTS FOR ALCOA
2091-T8 SHEET (0.063" X 48" X 48")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)		
MCAIR	LONG	2.0	128.6	107.0		
			130.3	108.4		
			127.1	107.0		
NORTHROP	LONG	2.0	127.3	72.8		
			129.9	76.0		
			130.2	74.7		
AVERAGE			128.9	91.0		
STANDARD DEVIATION			1.5	18.1		

TABLE J20
BEARING RESULTS FOR ALCOA
2091-T8 SHEET (0.063" X 48" X 48")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)		
MCAIR	L TRANS	2.0	131.2	110.7		
			130.6	109.5		
			128.3	107.0		
NORTHROP	L TRANS	2.0	130.4	85.2		
			129.7	85.0		
			129.0	88.2		
AVERAGE			129.9	97.6		
STANDARD DEVIATION			1.1	12.7		

TABLE J21

R-CURVE FRACTURE TOUGHNESS
RESULTS FOR 2091-T8X SHEET
(0.063" X 48" X 48")
Northrop

Specimen ID	Orientation	Kc
VIRLI	L-T	130.0

TABLE J22
 R-CURVE FRACTURE TOUGHNESS RESULTS
 For 20S1-T8 Sheet (0.063" x 48" x 48")
 MCDONNELL AIRCRAFT CO

SPECIMEN IDENTIFICATION: LT1
MATERIAL DESCRIPTION: 2091 AL-LI SHEET
SPECIMEN TYPE: C(T) (COMPACT SPECIMEN)
SPECIMEN ORIENTATION: L-T
YIELD STRENGTH: 49.5 KSI
SPECIMEN THICKNESS: 0.063 IN
SPECIMEN WIDTH: 3.999 IN

SPECIMEN IS INVALID PER ASTM E561-86, PARA. 7.5

APPLIED LOAD (lbs)	PHYSICAL CRACK LENGTH (in)	K _r (UNCORRECTED) (psi/in)	EFFECTIVE CRACK LENGTH (in)	K _r (CORRECTED) (psi/in)
800	1.485	42.884	1.629	47.141
975	1.500	52.765	1.753	62.495
1,025	1.507	55.716	1.810	68.349
1,100	1.516	60.171	1.935	80.342
1,150	1.523	63.194	***	***
1,175	1.529	64.829	***	***
1,200	1.534	66.420	***	***
1,225	1.545	68.270	***	***
1,250	1.555	70.121	***	***
1,275	FAILURE	---	---	---

*** Indicates that the equation for K_r (Corrected) did not converge to a solution.

TABLE J23
R-CURVE FRACTURE TOUGHNESS RESULTS
For 2091-T8 Sheet (0.063" x 48" x 48")
MCDONNELL AIRCRAFT CO

SPECIMEN IDENTIFICATION: LT2
MATERIAL DESCRIPTION: 2091 AL-LI SHEET
SPECIMEN TYPE: C(T) (COMPACT SPECIMEN)
SPECIMEN ORIENTATION: L-T
YIELD STRENGTH: 49.5 KSI
SPECIMEN THICKNESS: 0.064 IN
SPECIMEN WIDTH: 4.002 IN

SPECIMEN IS INVALID PER ASTM E561-86, PARA. 7.5

APPLIED LOAD (lbs)	PHYSICAL CRACK LENGTH (in)	K _r (UNCORRECTED) (psi/in)	EFFECTIVE CRACK LENGTH (in)	K _r (CORRECTED) (psi/in)
975	1.501	51,927	1.743	60,983
1,000	1.515	53,727	1.783	64,343
1,050	1.523	56,711	1.847	70,665
1,110	1.526	60,073	1.943	80,115
1,160	1.530	62,951	***	***
1,190	1.534	64,769	***	***
1,220	1.540	66,640	***	***
1,235	1.543	67,574	***	***
1,270	1.549	69,785	***	***
1,285	1.570	71,568	***	***
1,305	1.576	72,983	***	***
1,315	1.585	73,989	***	***
1,325	1.592	74,876	***	***
1,335	1.598	75,731	***	***
1,340	1.605	76,397	***	***
1,345	FAILURE	---	---	---

*** Indicates that the equation for K_r (Corrected) did not converge to a solution.

TABLE J24
 R-CURVE FRACTURE TOUGHNESS RESULTS
 For 2091-T8 Sheet (0.063" x 48" x 48")
 MCDONNELL AIRCRAFT CO

SPECIMEN IDENTIFICATION: TL1
MATERIAL DESCRIPTION: 2091 AL-LI SHEET
SPECIMEN TYPE: C(T) (COMPACT SPECIMEN)
SPECIMEN ORIENTATION: T-L
YIELD STRENGTH: 42.3 KSI
SPECIMEN THICKNESS: 0.064 IN
SPECIMEN WIDTH: 3.998 IN

SPECIMEN IS INVALID PER ASTM E561-86, PARA. 7.5

APPLIED LOAD (lbs)	PHYSICAL CRACK LENGTH (in)	K _r (UNCORRECTED) (psi/in)	EFFECTIVE CRACK LENGTH (in)	K _r (CORRECTED) (psi/in)
800	1.495	42,504	1.708	48,955
825	1.499	43,946	1.734	51,378
1,025	1.503	54,749	***	***
1,050	1.509	56,296	***	***
1,085	1.513	58,335	***	***
1,095	1.518	59,045	***	***
1,135	1.524	61,462	***	***
1,165	1.535	63,532	***	***
1,175	1.544	64,468	***	***
1,190	1.544	65,291	***	***
1,215	1.549	66,881	***	***
1,230	1.557	68,045	***	***
1,240	1.562	68,819	***	***
1,250	1.583	70,357	***	***
1,270	1.587	71,638	***	***
1,280	1.594	72,565	***	***
1,290	1.612	73,989	***	***
1,295	1.616	74,493	***	***
1,305	FAILURE	---	---	---

*** Indicates that the equation for K_r (Corrected) did not converge to a solution.

TABLE J25
R-CURVE FRACTURE TOUGHNESS RESULTS
For 2091-T8 Sheet (0.063" x 48" x 48")
MCDONNELL AIRCRAFT CO

SPECIMEN IDENTIFICATION: TL2
MATERIAL DESCRIPTION: 2091 AL-LI SHEET
SPECIMEN TYPE: C(T) (COMPACT SPECIMEN)
SPECIMEN ORIENTATION: T-L
YIELD STRENGTH: 42.3 KSI
SPECIMEN THICKNESS: 0.061 IN
SPECIMEN WIDTH: 3.999 IN

SPECIMEN IS INVALID PER ASTM E561-86, PARA. 7.5

APPLIED LOAD (lbs)	PHYSICAL CRACK LENGTH (in)	K _r (UNCORRECTED) (psi/in)	EFFECTIVE CRACK LENGTH (in)	K _r (CORRECTED) (psi/in)
950	1.507	53,350	2.062	79,002
975	1.511	54,882	***	***
1,075	1.517	60,775	***	***
1,120	1.522	63,517	***	***
1,130	1.526	64,248	***	***
1,180	1.531	67,305	***	***
1,240	1.541	71,181	***	***
1,255	1.544	72,179	***	***
1,265	1.550	73,059	***	***
1,280	1.569	74,867	***	***
1,285	1.576	75,466	***	***
1,295	FAILURE	---	---	---

*** Indicates that the equation for K_r (Corrected) did not converge to a solution.

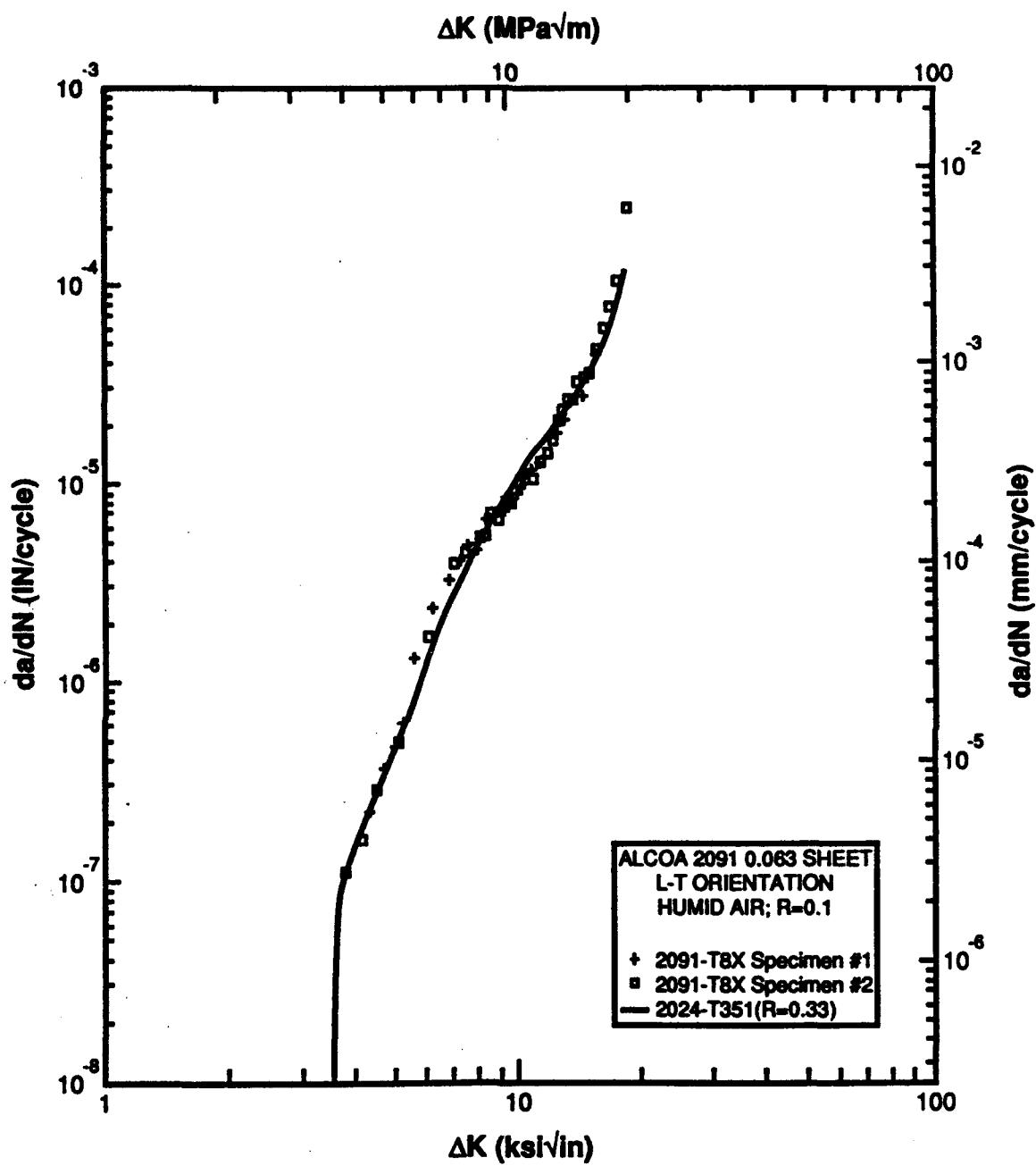


FIGURE J9. FATIGUE CRACK GROWTH RATE DATA for 2091-T8X 0.063 Inch Sheet Relative to 2024-T351 (L-T Orientation). Northrop.

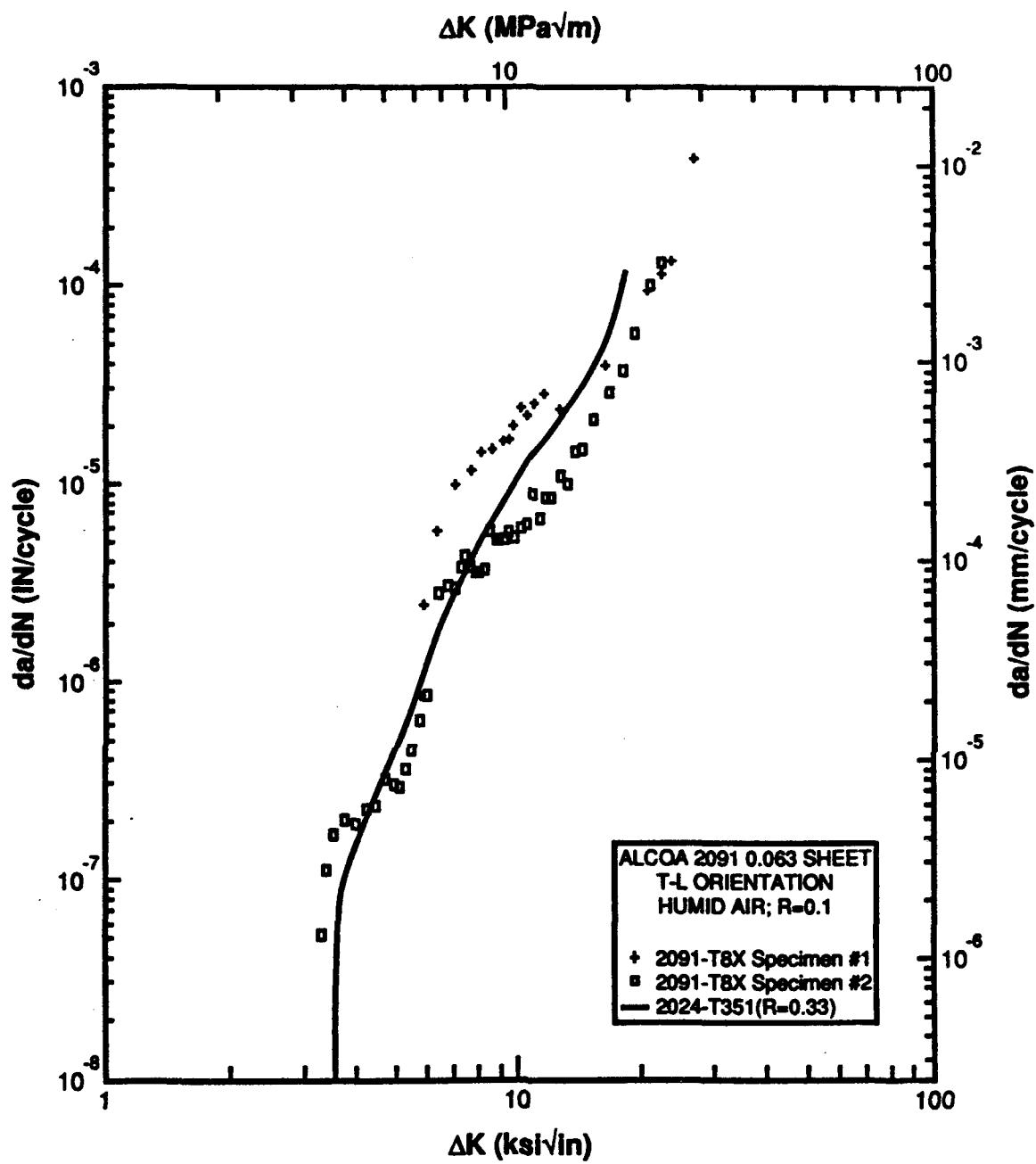


FIGURE J10. FATIGUE CRACK GROWTH RATE DATA for 2091-T8X 0.06² Inch Sheet Relative to 2024-T351 (T-L Orientation).

Northrop.

TABLE J26
FATIGUE CRACK GROWTH RATE DATA ASSOCIATED
WITH FIGURE J9

CRACK GROWTH TEST OF ALCOA 2091 .063" SHT SPEC V1FL1

M(T) SPECIMEN TYPE	L-T ORIENTATION
TEMP = R.T.	REL HUM = 95 % 22-AUG-89
H = 2.999 IN	B = .0612 IN R = .1
FREQUENCY = 10 HZ	H.A. ENVIRONMENT
GRID SPACING = .05 IN	FILE CODE: RK1:C00152.DDN
YIELD STRESS = 53 KSI	FITO CODE: RK1:C00152.DFO

SPECIMEN V1FL1				M(T) SPECIMEN TYPE			
REF #	K-MAX	2A IN	2A/W	K-BAR	DELTA K-BAR	DA/DN IN/CYC	VALID PER ASTM
1	4.74	.4671	.1558	4.85	4.36	2.26389E-07	Y
2	4.95	.5078	.1693	5.22	4.7	3.72283E-07	Y
3	5.48	.6106	.2036	5.6	5.04	4.90196E-07	Y
4	5.72	.6606	.2203	5.84	5.25	6.28289E-07	Y
5	5.95	.7083	.2362	6.24	5.61	1.37500E-06	Y
6	6.52	.8266	.2756	6.86	6.18	2.44167E-06	Y
7	7.21	.9731	.3245	7.53	6.78	3.37500E-06	Y
8	7.86	1.1081	.3695	8.06	7.26	4.12500E-06	Y
9	8.27	1.1906	.397	8.4	7.56	5.05000E-06	Y
10	8.53	1.2411	.4138	8.78	7.9	4.85000E-06	Y
11	9.04	1.3381	.4462	9.22	8.3	6.69999E-06	Y
12	9.4	1.4051	.4683	9.55	8.6	6.68749E-06	Y
13	9.71	1.4586	.4864	9.87	8.89	7.18752E-06	Y
14	10.04	1.5161	.5053	10.23	9.2	7.56250E-06	Y
15	10.41	1.5766	.5257	10.63	9.56	8.40624E-06	Y
16	10.85	1.6438	.5481	11.03	9.92	9.04167E-06	Y
17	11.21	1.6981	.5662	11.35	10.22	9.87500E-06	Y
18	11.49	1.7376	.5794	11.66	10.49	1.13750E-05	Y

TABLE J26 CONTINUED

REF #	SPECIMEN V1FL1		M(T) SPECIMEN TYPE				
	K-MAX	2A IN	2A/M	K-BAR	DELTA K-BAR	DA/DN IN/CYC	VALID PER ASTM
19	11.82	1.7831	.5946	12.01	10.81	1.22500E-05	Y
20	12.2	1.8321	.6109	12.41	11.17	1.30000E-05	Y
21	12.62	1.8841	.6282	12.86	11.57	1.38750E-05	Y
22	13.1	1.9396	.6467	13.34	12.01	1.73333E-05	Y
23	13.58	1.9916	.6641	13.85	12.46	1.81667E-05	Y
24	14.12	2.0461	.6823	14.34	12.91	2.16249E-05	Y
25	14.57	2.0893	.6967	14.87	13.38	2.65000E-05	Y
26	15.18	2.1423	.7144	16	14.4	2.83153E-05	Y
27	16.89	2.2726	.7578	17.3	15.57	4.45833E-05	Y
28	17.73	2.3261	.7756				

TABLE J27
FATIGUE CRACK GROWTH RATE DATA ASSOCIATED
WITH FIGURE J9

CRACK GROWTH TEST OF ALCOA 2091 .063" SHT SPEC V1FL3

M(T) SPECIMEN TYPE	L-T ORIENTATION	
TEMP = R.T.	REL HUM = 95 %	28-AUG-89
W = 2.999 IN	B = .0612 IN	R = .1
FREQUENCY = 10 HZ	H.A. ENVIRONMENT	
GRID SPACING = .05 IN	FILE CODE: RK1:C00154.PDN	
YIELD STRESS = 65 KSI	FITO CODE: RK1:C00154.DFO	

REF #	SPECIMEN V1FL3			M(T) SPECIMEN TYPE			
	K-MAX	2A IN	2A/W	K-BAR	DELTA K-BAR	DA/DN IN/CYC	VALID PER ASTM
1	3.87	.1891	.0631	4.2	3.78	1.14655E-07	Y
2	4.51	.2556	.0852	4.57	4.11	1.65625E-07	Y
3	4.63	.2688	.0896	5.01	4.51	2.99837E-07	Y
4	5.38	.3606	.1202	5.67	5.11	5.09740E-07	Y
5	5.96	.4391	.1464	6.67	6	1.71875E-06	Y
6	7.34	.6453	.2152	7.72	6.95	4.05000E-06	Y
7	8.1	.7668	.2357	8.25	7.42	4.62500E-06	Y
8	8.39	.8131	.2711	8.53	7.68	4.75000E-06	Y
9	8.68	.8606	.287	8.85	7.96	5.49999E-06	Y
10	9.02	.9156	.3053	9.19	8.27	5.65000E-06	Y
11	9.37	.9721	.3241	9.55	8.59	7.25000E-06	Y
12	9.73	1.0301	.3435	9.9	8.91	6.71875E-06	Y
13	10.06	1.0838	.3614	10.27	9.24	8.06250E-06	Y
14	10.48	1.1483	.3829	10.69	9.62	8.21875E-06	Y
15	10.91	1.2141	.4048	11.11	10	1.03333E-05	Y
16	11.32	1.2761	.4255	11.54	10.38	1.06667E-05	Y
17	11.76	1.3401	.4468	11.99	10.79	1.07500E-05	Y
18	12.22	1.4046	.4684	12.52	11.27	1.35000E-05	Y

TABLE J27 CONTINUED

REF #	SPECIMEN V1FL3		M(T) SPECIMEN TYPE			DA/DN IN/CYC	VALID PER ASTM
	K-MAX	2A IN	2A/W	K-BAR	DELTA K-BAR		
19	12.82	1.4856	.4954	13.05	11.74	1.46250E-05	Y
20	13.28	1.5441	.5149	13.47	12.12	1.73215E-05	Y
21	13.67	1.5926	.531	13.86	12.48	2.13637E-05	Y
22	14.06	1.6396	.5467	14.25	12.83	2.44444E-05	Y
23	14.45	1.6836	.5614	14.63	13.17	2.76667E-05	Y
24	14.82	1.7251	.5752	14.99	13.49	2.72727E-05	Y
25	15.16	1.7611	.5872	15.37	13.83	3.29545E-05	Y
26	15.58	1.8046	.6017	15.89	14.3	3.45930E-05	Y
27	16.2	1.8641	.6216	16.51	14.86	3.62500E-05	Y
28	16.83	1.9221	.6409	17.17	15.45	4.79167E-05	Y
29	17.51	1.9796	.6601	17.86	16.08	6.33334E-05	Y
30	18.23	2.0366	.6791	18.56	16.71	7.98387E-05	Y
31	18.9	2.0861	.6956	19.29	17.36	1.08000E-04	Y
32	19.69	2.1401	.7136	20.39	18.35	2.47143E-04	Y
33	21.11	2.2266	.7424				

TABLE J28
FATIGUE CRACK GROWTH RATE DATA ASSOCIATED
WITH FIGURE J10

CRACK GROWTH TEST OF ALCOA 2091 .063" SHT SPEC V1FT1
 M(T) SPECIMEN TYPE T-L ORIENTATION
 TEMP = R.T. REL HUM = 95 % 2-AUG-89
 W = 2.999 IN B = .061 IN R = .1
 FREQUENCY = 10 HZ H.A. ENVIRONMENT
 GRID SPACING = .05 IN FILE CODE: RK1:C00149.DDN
 YIELD STRESS = 47.7 KSI FITO CODE: RK1:C00149.DFO

REF #	SPECIMEN V1FT1			M(T) SPECIMEN TYPE			
	K-MAX	2A IN	2A/W	K-BAR	DELTA K-BAR	DA/DN IN/CYC	VALID PER ASTM
1	6.17	.8944	.2982	6.19	5.57	7.20342E-08	Y
2	6.21	.903	.3011	6.3	5.67	3.03622E-07	Y
3	6.39	.9457	.3153	6.7	6.03	9.37501E-07	Y
4	7.01	1.0875	.3626	7.39	6.65	1.94886E-06	Y
5	7.78	1.2589	.4198	8.01	7.21	2.42500E-06	Y
6	8.25	1.3559	.4521	8.4	7.56	3.18750E-06	Y
7	8.56	1.4197	.4734	8.9	8.01	3.32908E-06	Y
8	9.25	1.5502	.5169	9.39	8.45	3.78907E-06	Y
9	9.53	1.5987	.5331	9.65	8.69	3.93519E-06	Y
10	9.78	1.6412	.5472	10.01	9.01	4.76852E-06	Y
11	10.25	1.7185	.573	10.4	9.36	6.58086E-06	Y
12	10.54	1.7632	.5879	10.66	9.59	5.73277E-06	Y
13	10.77	1.7964	.599	11.01	9.91	6.93877E-06	Y
14	11.25	1.8644	.6217	11.59	10.44	8.15909E-06	Y
15	11.95	1.9542	.6516	12.52	11.26	6.33494E-06	Y
16	13.11	2.0847	.6951	15.77	14.19	1.27121E-05	Y
17	19.27	2.5042	.835	19.75	17.78	4.02498E-05	Y
18	20.25	2.5444	.8484	20.95	18.85	5.07503E-05	Y
19	21.68	2.5952	.8654	22.28	20.05	6.24998E-05	Y
20	22.91	2.6327	.8779	24.75	22.28	3.05000E-04	Y
21	26.87	2.7242	.9084				

TABLE J29
FATIGUE CRACK GROWTH RATE DATA ASSOCIATED
with FIGURE J10

CRACK GROWTH TEST OF ALCOA 2091 .063" SHT SPEC VIFT3

M(T) SPECIMEN TYPE	T-L ORIENTATION
TEMP = R.T.	REL HUM = 95 % 07-SEP-89
W = 2.999 IN	B = .0612 IN R = .1
FREQUENCY = 10 Hz	HUMID AIR ENVIRONMENT
GRID SPACING = .05 IN	FILE CODE: RK1:C00156.DDN
YIELD STRESS = 65 KSI	FIT0 CODE: RK1:C00156.DFO

REF #	SPECIMEN VIFT3		M(T) SPECIMEN TYPE			DA/DN IN/CYC	VALID PER ASTM
	K-MAX	2A IN	2A/W	K-BAR	DELTA K-BAR		
1	3.65	.2825	.0942	3.69	3.32	5.49999E-08	Y
2	3.72	.2935	.0979	3.8	3.42	1.18750E-07	Y
3	3.87	.3172	.1058	3.98	3.59	1.78750E-07	Y
4	4.09	.353	.1177	4.22	3.8	2.15000E-07	Y
5	4.34	.396	.132	4.48	4.04	1.99000E-07	Y
6	4.62	.4457	.1486	4.75	4.28	2.38750E-07	Y
7	4.88	.4935	.1646	5.01	4.51	2.57500E-07	Y
8	5.15	.545	.1817	5.29	4.76	3.46875E-07	Y
9	5.43	.6005	.2002	5.53	4.98	3.20313E-07	Y
10	5.63	.6415	.2139	5.72	5.14	3.16964E-07	Y
11	5.8	.677	.2257	5.89	5.3	3.83333E-07	Y
12	5.97	.7115	.2372	6.08	5.47	4.65000E-07	Y
13	6.19	.758	.2528	6.35	5.71	6.69999E-07	Y
14	6.51	.825	.2751	6.64	5.97	9.08335E-07	Y
15	6.77	.8795	.2933	7.06	6.35	2.92857E-06	Y
16	7.35	1.0025	.3343	7.51	6.76	3.25000E-06	Y
17	7.66	1.0675	.356	7.77	7	3.23943E-06	Y
18	7.89	1.1135	.3713	8	7.2	4.00862E-06	Y
19	8.12	1.16	.3868	8.22	7.4	4.52128E-06	Y
20	8.33	1.2025	.401	8.45	7.61	4.08335E-06	Y
21	8.58	1.2515	.4173	8.7	7.83	3.87499E-06	Y
22	8.82	1.298	.4328	8.92	8.03	3.80001E-06	Y

TABLE J29 CONTINUED

SPECIMEN V1FT3				H(T) SPECIMEN TYPE			
REF #	K-MAX	2A IN	2A/H	K-BAR	DELTA K-BAR	DA/DN IN/CYC	VALID PER ASTM
23	9.02	1.336	.4455	9.16	8.25	3.93940E-06	Y
24	9.31	1.388	.4628	9.47	8.53	6.19790E-06	Y
25	9.64	1.4475	.4827	9.75	8.78	5.50001E-06	Y
26	9.86	1.486	.4955	9.99	8.99	5.37500E-06	Y
27	10.12	1.529	.5098	10.27	9.25	5.55555E-06	Y
28	10.43	1.579	.5265	10.57	9.51	6.18055E-06	Y
29	10.71	1.6235	.5413	10.9	9.81	5.74999E-06	Y
30	11.09	1.681	.5605	11.28	10.15	6.62501E-06	Y
31	11.46	1.734	.5782	11.66	10.5	6.81250E-06	Y
32	11.87	1.7885	.5964	12.08	10.87	9.33333E-06	Y
33	12.3	1.8445	.615	12.51	11.26	7.21429E-06	Y
34	12.72	1.895	.6319	12.95	11.65	8.99998E-06	Y
35	13.19	1.949	.6499	13.44	12.09	9.08333E-06	Y
36	13.7	2.0035	.6681	14.04	12.63	1.14167E-05	Y
37	14.39	2.072	.6909	14.62	13.16	1.06250E-05	Y
38	14.85	2.1145	.7051	15.21	13.69	1.53750E-05	Y
39	15.58	2.176	.7256	16	14.4	1.61250E-05	Y
40	16.43	2.2405	.7471	17.05	15.35	2.22369E-05	Y
41	17.71	2.325	.7753	18.41	16.57	3.11539E-05	Y
42	19.16	2.406	.8023	19.84	17.86	3.88235E-05	Y
43	20.57	2.472	.8243	21.32	19.19	6.14998E-05	Y
44	22.12	2.5335	.8448	23.09	20.78	1.09167E-04	Y
45	24.14	2.599	.8666	24.88	22.39	1.36666E-04	Y
46	25.66	2.64	.8803				

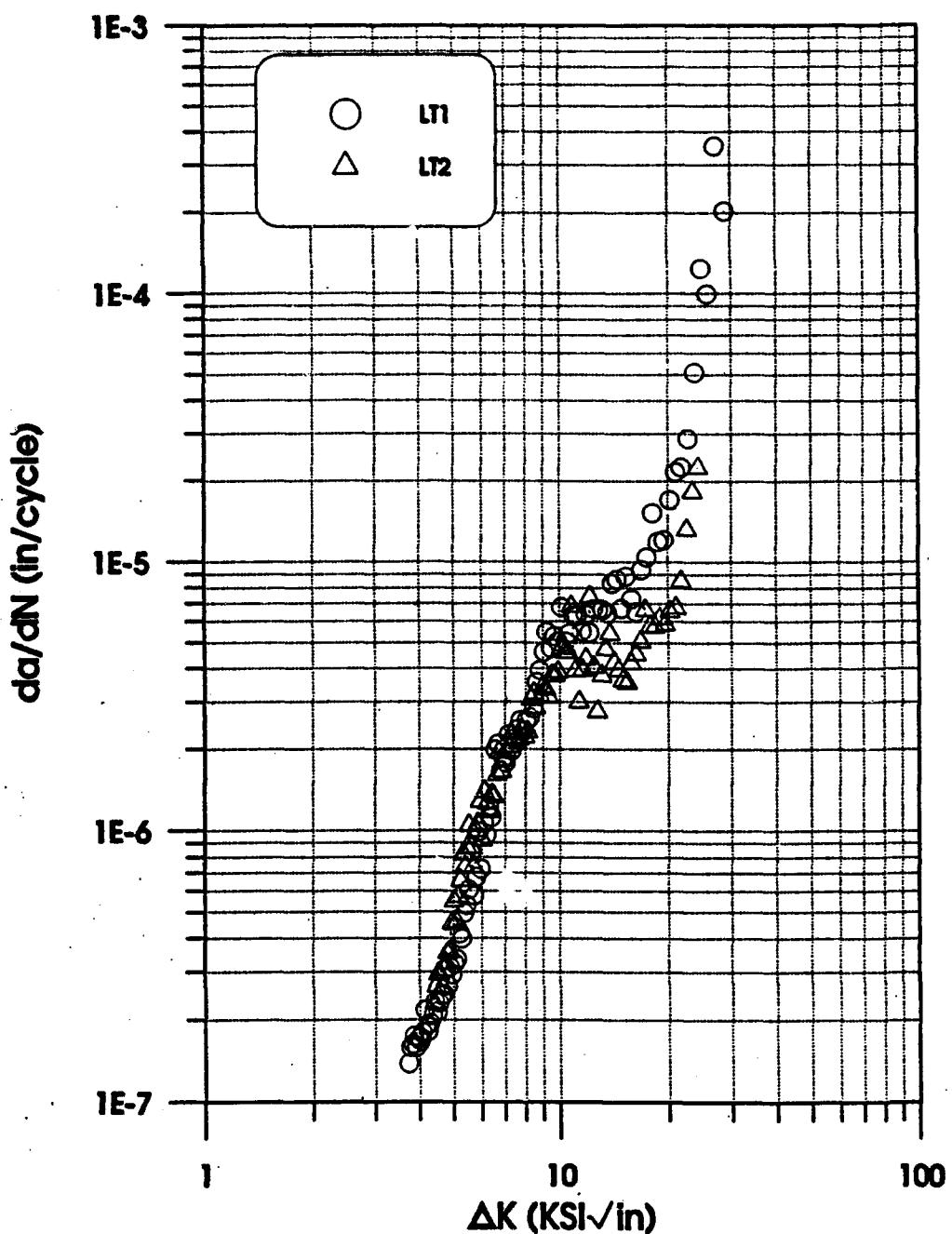


Figure J11 Figure Crack Growth Rate Data for
2091-T8 0.063 Inch Sheet. (L-T Orientation, R=0.33,
Lab Air and 75°F).
McDonnell Aircraft Company.

TABLE J30

Fatigue Crack Growth Rate Data Associated with Figure J11 (Specimen LT1)

TR NUMBER: TR 515-450 FORM: 0.063 SHEET
 ALLOY: Al2091-T8 ORIENT: L-LI R-RATIO: 0.330 ENVIR: LA DATE: 1-MAY-98
 SPECIMEN TYPE: C(T) GROUP: WSP TEMP: 75F FREQ: VAR
 COMMENT: ALCOA MATERIAL FTU: 62.2 KSI FY: 49.5 KSI ULT STRAIN: 0.088 E: 5600. KSI MU: 0.300 ELON: 21.9% RED A: 0.05
 LOC IN STOCK: UN SPEC THICKNESS: 0.062 IN WIDTH: 4.000 IN MAX TEST LOAD: 0.100 KIPS DATA FILE: AL-31

FRONT	BACK	AVERAGE	CRACK LENGTH-A (INCH)	DELTA CYCLES	TOTAL CYCLES	(KSI IN ^{1/2})	AVERAGE DELTA K (KSI IN ^{-1/2})	DA/DN (INCH/CYCLE)		
									DA/DN	DA/DN
1.520	1.403	1.492	1.502	0	150000	150000	3.69	3.71	1.39E-17	1.39E-17
1.535	1.510	1.522	1.510	0	110000	260000	3.74	3.78	1.59E-07	1.59E-07
1.551	1.529	1.539	1.559	0	120000	300000	3.83	3.81	1.63E-07	1.63E-07
1.570	1.549	1.559	1.559	0	115000	495000	3.88	3.85	1.75E-07	1.75E-07
1.588	1.571	1.589	1.600	0	125000	620000	3.93	3.91	1.59E-07	1.59E-07
1.608	1.591	1.600	1.600	0	115000	735000	3.98	3.96	1.71E-07	1.71E-07
1.630	1.609	1.609	1.619	0	115000	870000	4.04	4.01	1.67E-07	1.67E-07
1.655	1.628	1.642	1.642	0	135000	870000	4.09	4.07	1.60E-07	1.60E-07
1.670	1.659	1.669	1.669	0	100000	970000	4.09	4.07	1.62E-07	1.62E-07
1.691	1.668	1.668	1.679	0	90000	100000	4.15	4.12	2.18E-07	2.18E-07
1.707	1.692	1.692	1.699	0	110000	117000	4.29	4.18	1.82E-07	1.82E-07
1.726	1.713	1.713	1.719	0	110000	128000	4.26	4.23	1.82E-07	1.82E-07
1.746	1.732	1.740	1.740	0	105000	130500	4.32	4.29	1.94E-07	1.94E-07
1.765	1.753	1.760	1.760	0	95000	140000	4.38	4.35	2.08E-07	2.08E-07
1.799	1.773	1.782	1.782	0	95000	157500	4.45	4.41	2.33E-07	2.33E-07
1.806	1.793	1.800	1.800	0	85000	160000	4.51	4.48	2.14E-07	2.14E-07
1.828	1.813	1.821	1.821	0	90000	175000	4.57	4.54	2.31E-07	2.31E-07
1.850	1.831	1.840	1.840	0	88000	183000	4.64	4.60	2.46E-07	2.46E-07
1.867	1.853	1.860	1.860	0	88000	191000	4.70	4.67	2.49E-07	2.49E-07
1.887	1.874	1.880	1.880	0	65000	197500	4.77	4.74	3.08E-07	3.08E-07
1.907	1.894	1.896	1.900	0	75000	205000	4.84	4.81	2.69E-07	2.69E-07
1.927	1.916	1.922	1.922	0	68000	211000	4.92	4.88	3.13E-07	3.13E-07
1.946	1.933	1.939	1.939	0	68000	217000	4.98	4.95	2.94E-07	2.94E-07
1.964	1.956	1.960	1.960	0	63000	224000	5.06	5.02	3.23E-07	3.23E-07
1.984	1.976	1.980	1.980	0	68000	230000	5.14	5.10	3.35E-07	3.35E-07
2.007	1.995	2.001	2.001	0	50000	235100	5.22	5.18	4.16E-07	4.16E-07
2.026	2.015	2.021	2.021	0	50000	240100	5.38	5.26	3.98E-07	3.98E-07
2.047	2.034	2.040	2.040	0	40000	244100	5.39	5.34	4.95E-07	4.95E-07
2.066	2.052	2.059	2.059	0	36000	247700	5.47	5.43	5.31E-07	5.31E-07
2.084	2.074	2.079	2.079	0	33000	251000	5.55	5.51	6.05E-07	6.05E-07
2.105	2.095	2.100	2.100	0	25000	255500	5.65	5.60	6.34E-07	6.34E-07
2.125	2.115	2.120	2.120	0	35000	257000	5.74	5.70	5.74E-07	5.74E-07
2.145	2.136	2.141	2.141	0	38000	260000	5.84	5.79	6.73E-07	6.73E-07
2.165	2.156	2.160	2.160	0	28000	262000	5.94	5.89	9.90E-07	9.90E-07
2.184	2.176	2.180	2.180	0	27000	264700	6.04	5.99	7.22E-07	7.22E-07
2.206	2.196	2.201	2.201	0	28000	266700	6.15	6.09	1.07E-06	1.07E-06
2.224	2.215	2.220	2.220	0	19000	269800	6.24	6.20	9.63E-07	9.63E-07
2.243	2.236	2.239	2.239	0	16000	270200	6.35	6.30	1.23E-06	1.23E-06
2.263	2.255	2.259	2.259	0	18000	272000	6.47	6.41	1.12E-06	1.12E-06
2.286	2.280	2.283	2.283	0	12000	272000	6.61	6.54	1.99E-06	1.99E-06

TABLE J30 CONTINUED

TR NUMBER: TR 515-459

FRONT	CRACK LENGTH-A (INCH)		DELTA CYCLES	TOTAL CYCLES	DELTA K (KSI IN ^{-1/2})	AVERAGE DETA K (KSI IN ^{-1/2})	DA/DN (INCH/CYCLE)
	BACK	AVERAGE					
2.397	2.392	2.394	16000	2742000	6.74	6.67	2.10E-06
2.322	2.316	2.319	9000	2751000	6.83	6.78	1.67E-06
2.343	2.346	2.349	11000	2762000	6.96	6.90	1.65E-06
2.362	2.356	2.359	11000	2773000	7.09	7.03	1.78E-06
2.382	2.377	2.380	9000	2782000	7.23	7.16	2.27E-06
2.402	2.397	2.399	16000	2792000	7.37	7.30	1.97E-06
2.423	2.417	2.420	9500	2801500	7.53	7.45	2.28E-06
2.442	2.436	2.439	8000	2809500	7.67	7.60	2.37E-06
2.461	2.458	2.459	7900	2817400	7.83	7.75	2.56E-06
2.483	2.475	2.479	8500	2825500	7.99	7.91	2.33E-06
2.505	2.494	2.500	8000	28333900	8.16	8.08	2.56E-06
2.522	2.517	2.519	7500	2841400	8.33	8.25	2.63E-06
2.542	2.542	2.542	8000	2849400	8.54	8.44	2.04E-06
2.562	2.557	2.560	5000	2854400	8.71	8.62	3.56E-06
2.581	2.578	2.580	5000	2859400	8.90	8.80	3.94E-06
2.601	2.599	2.600	4500	2863900	9.11	9.01	4.62E-06
2.617	2.621	2.617	3500	2867400	9.31	9.21	5.46E-06
2.642	2.642	2.640	4400	2871800	9.54	9.43	4.75E-06
2.659	2.661	2.660	3700	2875500	9.76	9.65	5.27E-06
2.680	2.689	2.689	4000	2879500	10.00	9.88	5.03E-06
2.702	2.699	2.700	3600	2882500	10.25	10.13	6.89E-06
2.723	2.710	2.720	4000	2886500	10.51	10.38	5.03E-06
2.740	2.738	2.739	3500	2890000	10.76	10.64	5.41E-06
2.762	2.759	2.760	3300	2893300	11.05	10.91	6.32E-06
2.786	2.776	2.781	3300	2896600	11.36	11.20	6.29E-06
2.802	2.799	2.801	3600	2900200	11.66	11.51	5.49E-06
2.825	2.816	2.821	3200	2903400	11.98	11.82	6.37E-06
2.843	2.837	2.840	3500	2906500	12.30	12.14	5.44E-06
2.864	2.855	2.860	2900	2909600	12.63	12.46	6.67E-06
2.883	2.876	2.879	3000	2912800	12.99	12.81	6.65E-06
2.903	2.896	2.899	3000	2915800	13.37	13.18	6.63E-06
2.923	2.917	2.920	3200	2919000	13.70	13.58	6.44E-06
2.944	2.938	2.941	2500	2921500	14.22	14.00	8.34E-06
2.962	2.959	2.961	2300	2923800	14.66	14.44	8.61E-06
2.981	2.978	2.979	2800	2926600	15.09	14.87	6.71E-06
3.002	2.998	3.000	2300	2928900	15.59	15.34	8.87E-06
3.022	3.017	3.020	2700	2931600	16.09	15.84	7.30E-06
3.042	3.038	3.040	3200	2934800	16.37	16.15	6.50E-06
3.062	3.060	3.061	2200	2937000	17.24	16.95	9.34E-06
3.081	3.078	3.080	1000	2938800	17.80	17.52	1.04E-05

TABLE J30 CONTINUED

TR NUMBER: TR 515-450

CRACK LENGTH-A (INCH)		DELTA CYCLES	TOTAL CYCLES	AVERAGE DELTA K (KSI IN ^{-1/2})	DA/DN (INCH/CYCLE)
FRONT	BACK				
3.192	3.190	3.191	1460	2940200	18.48
3.121	3.118	3.120	1600	2941800	19.12
3.143	3.138	3.140	1700	2943500	19.85
3.164	3.157	3.161	1200	2944700	20.63
3.184	3.177	3.180	900	2945600	21.42
3.203	3.198	3.201	900	2946500	22.29
3.223	3.218	3.221	700	2947200	23.21
3.246	3.237	3.241	400	2947600	24.21
3.264	3.256	3.260	150	2947750	25.16
3.282	3.279	3.281	210	2947900	26.35
3.308	3.303	3.305	70	2948030	27.05
3.341	3.331	3.336	15	2948055	28.87

*- DENOTES THAT DATA POINT IS INVALID PER ASTM TEST METHOD E647-88, PARAGRAPH 6.8.3

**- DENOTES THAT DATA POINT IS INVALID PER ASTM TEST METHOD E647-88, PARAGRAPH 7.2.1

***- DENOTES THAT DATA POINT IS INVALID PER ASTM TEST METHOD E647-88, PARAGRAPHS 6.8.3 AND 7.2.1

TABLE J31

FIGURE CRACK GROWTH RATE DATA ASSOCIATED WITH FIGURE J11 (Specimen LT2)

TR NUMBER: TR 515-450 FORM: 0.063 SHEET ORIENT: L-LT SPECIMEN TYPE: C(T) GROUP: NSP DATE: 1-MAY-98
 ALLOY: AL2091-18 R-RATIO: 0.330 ENVIR: LA TEP: 7SF FREQ: VAR
 COMMENT: ALCOA MATERIAL FTU: 49.5 KSI ULT STRAIN: 0.080 E: 5600. KSI MU: 0.300 ELON: 21.07 RED A: 0.07
 LOC IN STOCK: UN SPEC THICKNESS: 0.062 IN WIDTH: 4.000 IN MAX TEST LOAD: 0.100 KIPS DATA FILE: AL2091-32

CRACK LENGTH--A (INCH)	DELTA CYCLES	TOTAL CYCLES	AVERAGE DELTA K (KSI IN ⁻¹ /2)	AVERAGE DELTA K (KSI IN ⁻¹ /2)	DA/DN (INCH/CYCLE)
FRONT	BACK	AVERAGE			
1.479	1.482	1.480	0	0	4.36
1.496	1.504	1.500	85000	85000	4.42
1.516	1.523	1.519	73000	158000	4.48
1.537	1.544	1.541	72000	230000	4.54
1.556	1.563	1.560	65000	295000	4.60
1.580	1.584	1.582	85000	380000	4.66
1.598	1.603	1.600	60000	440000	4.72
1.617	1.622	1.620	60000	500000	4.78
1.638	1.641	1.640	56000	550000	4.84
1.657	1.661	1.659	55000	610000	4.91
1.677	1.682	1.680	45000	650000	4.98
1.697	1.703	1.700	37000	693000	5.05
1.716	1.724	1.720	40000	737000	5.12
1.737	1.742	1.740	34000	771000	5.18
1.756	1.764	1.760	31000	802000	5.26
1.776	1.783	1.780	25000	827000	5.33
1.795	1.803	1.799	26000	653000	5.40
1.815	1.824	1.820	23500	876500	5.48
1.835	1.844	1.839	19000	895500	5.56
1.856	1.864	1.860	24000	919500	5.64
1.875	1.883	1.879	25000	945300	5.72
1.896	1.904	1.900	21000	966300	5.81
1.915	1.926	1.920	19130	985630	5.90
1.929	1.950	1.940	15000	1006630	5.98
1.955	1.965	1.960	22000	1022630	6.07
1.976	1.984	1.960	14100	1036730	6.17
1.996	2.004	2.000	16000	1052730	6.26
2.017	2.023	2.020	17000	1069730	6.36
2.036	2.044	2.040	15000	1084730	6.46
2.055	2.065	2.060	15000	1099730	6.56
2.075	2.085	2.080	12500	1112230	6.67
2.095	2.105	2.100	10500	1122730	6.78
2.116	2.124	2.120	12000	1134730	6.89
2.137	2.144	2.140	11000	1145730	7.00
2.156	2.164	2.160	10000	1155730	7.12
2.176	2.184	2.180	10000	1165730	7.25
2.196	2.204	2.200	8500	1174230	7.37
2.215	2.224	2.219	9000	1183230	7.49
2.235	2.245	2.240	9700	1192930	7.63
2.257	2.263	2.260	9000	1201930	7.76

TABLE J31 CONTINUED

TR NUMBER: TR 515-450

FRONT	BACK	AVERAGE	CRACK LENGTH--A (INCH)	DELTA CYCLES	TOTAL CYCLES	DELTA K (KSI IN ^{-1/2})	AVERAGE DELTA K (KSI IN ^{-1/2})	DA/DN (INCH/CYCLE)
2.276	2.284	2.280	8500	1210430	7.91	7.83	2.38E-06	
2.296	2.303	2.300	9000	1229430	8.05	7.98	2.22E-06	
2.313	2.324	2.316	8900	1227430	8.19	8.12	2.32E-06	
2.337	2.345	2.341	7500	1234930	8.37	8.28	3.06E-06	
2.357	2.364	2.361	6800	1240930	8.52	8.44	3.22E-06	
2.376	2.384	2.380	6700	1247630	8.68	8.60	3.26E-06	
2.399	2.403	2.401	6700	1253330	8.86	8.77	3.16E-06	
2.416	2.424	2.420	5500	1259830	9.03	8.94	3.41E-06	
2.437	2.442	2.439	5900	1265730	9.21	9.12	3.35E-06	
2.458	2.462	2.460	6600	1272330	9.40	9.30	3.13E-06	
2.477	2.485	2.481	5500	1277830	9.61	9.50	3.79E-06	
2.496	2.505	2.500	5200	1283030	9.86	9.70	3.76E-06	
2.515	2.524	2.519	4900	1289230	10.00	9.90	3.87E-06	
2.538	2.544	2.541	4500	1294330	10.24	10.12	4.77E-06	
2.555	2.563	2.559	4800	1296430	10.44	10.34	4.60E-06	
2.577	2.581	2.579	4300	1300730	10.67	10.56	4.59E-06	
2.591	2.607	2.599	5300	1306630	10.92	10.80	3.83E-06	
2.615	2.625	2.620	5600	1311430	11.19	11.05	3.91E-06	
2.636	2.644	2.640	6500	1317930	11.44	11.32	3.80E-06	
2.655	2.665	2.660	5000	1322930	11.71	11.58	3.94E-06	
2.680	2.682	2.681	5000	1327930	12.02	11.87	4.34E-06	
2.695	2.704	2.700	2500	1330430	12.29	12.16	7.40E-06	
2.715	2.725	2.720	5000	1335430	12.61	12.45	4.94E-06	
2.735	2.744	2.739	7000	1342430	12.92	12.76	2.77E-06	
2.755	2.766	2.760	5500	1347930	13.26	13.09	3.76E-06	
2.778	2.783	2.780	4300	1352230	13.62	13.44	4.72E-06	
2.798	2.802	2.800	3600	1355830	13.97	13.79	5.40E-06	
2.819	2.823	2.821	5000	1360830	14.37	14.17	4.21E-06	
2.837	2.841	2.839	4700	1365530	14.74	14.56	3.94E-06	
2.857	2.864	2.861	5900	1371430	15.18	14.96	3.61E-06	
2.877	2.882	2.879	5300	1376730	15.59	15.39	3.53E-06	
2.897	2.904	2.900	5000	1381730	16.07	15.83	4.18E-06	
2.916	2.921	2.920	4300	1386030	16.53	16.30	4.52E-06	
2.936	2.942	2.939	3900	1389930	17.03	16.78	5.04E-06	
2.955	2.967	2.961	3300	1393230	17.60	17.32	6.61E-06	
2.978	2.981	2.980	3200	1396430	18.12	17.86	5.77E-06	
2.998	3.003	3.000	3600	1400030	18.72	18.42	5.72E-06	
3.016	3.024	3.020	3250	1403280	19.33	19.02	6.14E-06	
3.038	3.041	3.034	3300	1406580	19.96	19.64	5.86E-06	
3.056	3.064	3.060	3100	1409680	20.65	20.30	6.55E-06	

TABLE J31. CONTINUED

TR NUMBER: TR 515-458

CRACK LENGTH--A (INCH)		DELTA CYCLES		TOTAL CYCLES		DELTA K (KSI IN ^{-1/2})		AVERAGE DELTA K (KSI IN ^{-1/2})		DA/DN (INCH/CYCLE)	
FRONT	BACK	AVERAGE									
3.076	3.084	3.080		3000		1412680		21.38		21.82	
3.098	3.105	3.101		2500		1415180		22.19		21.79	
3.116	3.126	3.121		1500		1416680		23.00		22.59	
3.137	3.145	3.141	*	1100		1417780		23.86		23.43	
3.151	3.167	3.159	*	800		1418580		24.68		24.27	

*- DENOTES THAT DATA POINT IS INVALID PER ASTM TEST METHOD E647-88, PARAGRAPH 8.8.3

**- DENOTES THAT DATA POINT IS INVALID PER ASTM TEST METHOD E647-88, PARAGRAPH 7.2.1
***- DENOTES THAT DATA POINT IS INVALID PER ASIN TEST METHOD E647-88, PARAGRAPHS 8.8.3 AND 7.2.1

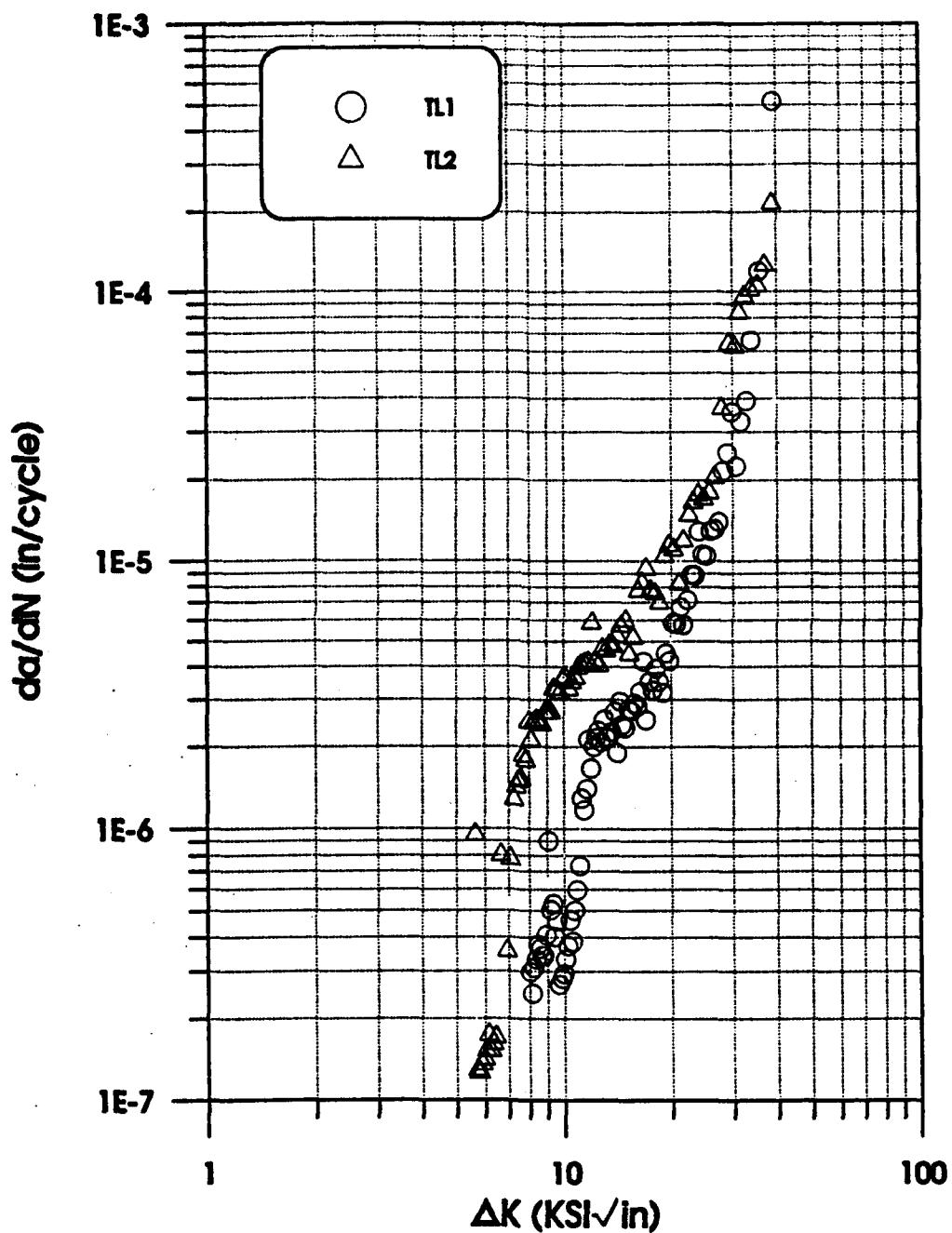


Figure J12 Fatigue Crack Growth Rate Data for
2091-T8 0.063 Inch Sheet (T-L Orientation,
Lab Air, 75°F, and TL1 R=0.02 and TL2 R=0.10).
McDonnell Aircraft Company

TABLE J32
FATIGUE CRACK GROWTH RATE DATA ASSOCIATED with FIGURE J12 (Specimen TL1)
 TR NUMBER: TR 515-459 FORM: 0.063 SHEET ORIENT: LT-L SPECIMEN TYPE: C(T) GROUP: MAP DATE: 1-MAY-90
 ALLOT: AL2091-18 R-RATIO: 0.020 ENVIR: LA TEMP: 75°F FREQ: VAR
 COMPONENT: ALCOA MATERIAL FTU: 65.2 KSI FY: 42.3 KSI ULT STRAIN: 0.080 E: 5700. KSI MU: 0.300 EL01: 18.3% RED A: 0.01
 LOC IN STOCK: UM SPEC THICKNESS: 0.062 IN WIDTH: 4.000 IN MAX TEST LOAD: 0.200 KIPS DATA FILE: AL-27

CRACK LENGTH-A (INCH)	FRONT		BACK		TOTAL CYCLES	DELTA K (KSI IN ^{1/2})	AVERAGE DELTA K (KSI IN ^{1/2})	DA/DN (INCH/CYCLE)
	BACK	AVERAGE	BACK	AVERAGE				
1.498	1.462	1.499	1.499	1.499	0	65000	7.90	2.99E-07
1.518	1.481	1.521	1.521	1.521	65000	150000	8.03	2.49E-07
1.540	1.501	1.521	1.540	1.540	62500	212500	8.13	2.10E-07
1.559	1.521	1.560	1.560	1.560	66666	272500	8.24	3.32E-07
1.578	1.542	1.569	1.569	1.569	52000	324500	8.35	3.77E-07
1.598	1.560	1.579	1.579	1.579	56250	386750	8.46	3.64E-07
1.617	1.583	1.600	1.600	1.600	60000	440750	8.57	3.42E-07
1.637	1.604	1.620	1.620	1.620	65000	495750	8.69	3.42E-07
1.656	1.622	1.639	1.639	1.639	55000	545750	8.80	4.09E-07
1.680	1.639	1.660	1.660	1.660	50000	590750	8.92	4.73E-07
1.701	1.661	1.681	1.681	1.681	45000	628750	9.11	5.05E-07
1.721	1.679	1.700	1.700	1.700	38000	665750	9.23	9.17
1.740	1.700	1.720	1.720	1.720	37000	710750	9.35	9.29
1.764	1.718	1.741	1.741	1.741	53000	710750	9.49	9.42
1.780	1.739	1.759	1.759	1.759	46666	758750	9.61	9.55
1.801	1.761	1.781	1.781	1.781	89000	838750	9.75	9.69
1.820	1.784	1.802	1.802	1.802	75000	913750	9.90	2.83E-07
1.835	1.802	1.820	1.820	1.820	66666	973750	10.03	9.83
1.860	1.819	1.839	1.839	1.839	59000	1032750	10.17	10.19
1.884	1.836	1.860	1.860	1.860	55000	1087750	10.32	10.24
1.895	1.862	1.879	1.879	1.879	42000	1129750	10.46	10.39
1.919	1.882	1.900	1.900	1.900	55000	1184750	10.63	10.54
1.939	1.901	1.920	1.920	1.920	40000	1224750	10.76	10.79
1.958	1.921	1.940	1.940	1.940	32000	1256750	10.94	10.86
1.980	1.943	1.961	1.961	1.961	30000	1296750	11.12	11.03
2.001	1.961	1.981	1.981	1.981	15000	1301750	11.28	11.26
2.019	1.982	2.001	2.001	2.001	17000	1310750	11.46	11.37
2.042	2.001	2.022	2.022	2.022	15000	1333750	11.65	11.75
2.060	2.022	2.041	2.041	2.041	9000	1342750	11.82	12.49
2.078	2.042	2.060	2.060	2.060	11500	1354250	12.00	12.71
2.099	2.061	2.080	2.080	2.080	10000	1364250	12.20	12.94
2.118	2.081	2.100	2.100	2.100	9000	1373250	12.39	13.15
2.137	2.102	2.119	2.119	2.119	6500	1381750	12.59	12.49
2.159	2.126	2.142	2.142	2.142	11000	1392750	12.83	12.71
2.180	2.145	2.162	2.162	2.162	6000	1400750	13.05	12.94
2.199	2.163	2.181	2.181	2.181	8500	1409250	13.25	13.15
2.219	2.181	2.200	2.200	2.200	6750	1416000	13.47	13.36
2.240	2.203	2.222	2.222	2.222	9500	1427500	13.73	13.60
2.260	2.221	2.240	2.240	2.240	7000	1434500	13.96	13.84
2.274	2.245	2.260	2.260	2.260	10000	1444500	14.19	14.07

TABLE J32 CONTINUED

TR NUMBER: TR 515-450

FRONT	CRACK LENGTH-A (INCH)		DELTA CYCLES	TOTAL CYCLES	DELTAK (KSI IN ⁻¹ /2)	AVERAGE DELTAK (FSI IN ⁻¹ /2)	DA/DN (INCH/CYCLE)
	BACK	AVERAGE					
2.299	2.262	2.289	7000	1451500	14.46	14.33	2.90E-06
2.317	2.285	2.301	8500	1460000	14.73	14.60	2.42E-06
2.334	2.305	2.320	8000	1460000	14.99	14.86	2.36E-06
2.357	2.324	2.340	7500	1475500	15.29	15.14	2.76E-06
2.376	2.313	2.360	7000	1482500	15.57	15.43	2.73E-06
2.395	2.365	2.386	7000	1489500	15.87	15.72	2.91E-06
2.424	2.381	2.403	8000	1497500	16.23	16.05	2.84E-06
2.441	2.403	2.422	6000	1503500	16.54	16.38	3.22E-06
2.457	2.424	2.441	4500	1508000	16.86	16.70	4.19E-06
2.476	2.444	2.460	7500	1515500	17.19	17.02	2.53E-06
2.499	2.462	2.481	6000	1521500	17.56	17.37	3.52E-06
2.520	2.484	2.502	6500	1528000	17.96	17.76	3.26E-06
2.535	2.507	2.521	4750	1532750	18.32	18.14	3.94E-06
2.553	2.525	2.539	5250	1538000	18.68	18.50	3.52E-06
2.578	2.545	2.562	7000	1545000	19.15	18.91	3.19E-06
2.594	2.566	2.580	10000	1549000	19.53	19.34	4.50E-06
2.617	2.598	2.603	5500	1554500	20.05	19.79	4.22E-06
2.641	2.606	2.623	3500	1558000	20.53	20.29	5.87E-06
2.656	2.625	2.641	3000	1561000	20.94	20.74	5.88E-06
2.676	2.646	2.661	3000	1564000	21.45	21.20	6.70E-06
2.700	2.659	2.679	3200	1567200	21.92	21.69	5.75E-06
2.716	2.684	2.701	3000	1570200	22.50	22.21	7.13E-06
2.739	2.703	2.721	2300	1572500	23.08	22.79	8.89E-06
2.759	2.724	2.741	2300	1574800	23.68	23.38	8.89E-06
2.774	2.748	2.761	1500	1576300	24.27	23.97	1.29E-05
2.797	2.763	2.780	1800	1578100	24.88	24.57	1.06E-05
2.819	2.781	2.800	1900	1580000	25.55	25.21	1.05E-05
2.835	2.805	2.820	1550	1581550	26.25	25.90	1.30E-05
2.853	2.827	2.846	1500	1583050	26.97	26.61	1.32E-05
2.872	2.850	2.861	1500	1584550	27.77	27.37	1.40E-05
2.893	2.867	2.880	900	1585450	28.54	28.15	2.16E-05
2.915	2.886	2.900	800	1586250	29.38	28.96	2.51E-05
2.931	2.909	2.920	550	1586800	30.23	29.81	3.55E-05
2.950	2.930	2.940	900	1587700	31.16	30.70	2.24E-05
2.973	2.947	2.960	600	1588300	32.11	31.64	3.28E-05
2.995	2.971	2.983	600	1588900	33.31	32.71	3.93E-05
3.021	2.993	3.007	36	1589260	34.59	33.95	6.58E-05
3.055	3.028	3.041	290	1589550	36.61	35.69	1.19E-04
3.126	3.100	3.113**	140	1589690	41.45	39.83	5.13E-04

*- DENOTES THAT DATA POINT IS INVALID PER ASTM TEST METHOD E647-88, PARAGRAPH 8.8.3

**- DENOTES THAT DATA POINT IS INVALID PER ASTM TEST METHOD E647-88, PARAGRAPH 7.2.1

***- DENOTES THAT DATA POINT IS INVALID PER ASTM TEST METHOD E647-88, PARAGRAPHS 8.8.3 AND 7.2.1

TABLE J33
FATIGUE CRACK GROWTH RATE DATA ASSOCIATED WITH FIGURE J12 (SPECIMEN TL2)

TR NUMBER: TR 515-459	FORM: 0.063 SHEET	ORIENT: LT-L	R-RATIO: 0.100	SPECIMEN TYPE: C(T)	GROUP: MAP	DATE: 1-MAY-98
ALLOY: AL2091-18						ENVIR: LA
COMMENT: ALCOA MATERIAL						TEMP: 75F
FTU: 65.2 KSI FTY: 42.3 KSI ULT STRAIN: 0.080	E: 5700. KSI MU: 0.340	ELON: 18.3%	RED A: 0.01	LOC IN STOCK: UN SPEC THICKNESS: 0.062 IN	TEST LOAD: 0.100 KIPS	DATA FILE: AL-28
CRACK LENGTH--A (INCH)	DELTA CYCLES	TOTAL CYCLES	DELTA K (KSI IN ^{-1/2})	AVERAGE DELTA K (KSI IN ^{-1/2})	DA/DN (INCH/CYCLE)	
FRONT	BACK	AVERAGE	(KSI IN ^{-1/2})	(KSI IN ^{-1/2})	(INCH/CYCLE)	
1.671	1.668	1.670	0	0	5.53	1.20E-07
1.695	1.698	1.691	168150	168150	5.62	5.57
1.714	1.707	1.710	200000	368150	5.69	9.50E-08
1.733	1.727	1.730	155000	523150	5.76	5.73
1.751	1.748	1.749	155000	678150	5.84	5.80
1.773	1.767	1.770	155000	633150	5.93	5.89
1.792	1.788	1.790	140000	973150	6.01	5.97
1.815	1.806	1.810	135000	1108150	6.10	6.05
1.835	1.826	1.830	115000	1223150	6.16	6.14
1.853	1.847	1.850	130000	1353150	6.27	6.23
1.874	1.868	1.871	130000	1483150	6.37	6.32
1.893	1.890	1.891	120000	1603150	6.46	6.42
1.975	1.971	1.973	102000	1705150	6.87	6.66
1.994	1.999	1.992	530000	1758150	6.97	6.92
2.031	2.030	2.030	500000	1808150	7.16	7.07
2.051	2.048	2.050	150000	1823150	7.29	7.23
2.073	2.066	2.069	140000	1937150	7.40	7.34
2.090	2.090	2.090	140000	1851150	7.53	7.47
2.111	2.109	2.110	130000	1864150	7.65	7.59
2.132	2.129	2.130	110000	1975150	7.78	7.71
2.152	2.148	2.150	110000	1886150	7.90	7.84
2.173	2.166	2.169	80000	1894150	8.04	7.97
2.191	2.188	2.190	95000	1903650	8.18	8.11
2.212	2.207	2.209	80000	1911650	8.31	8.24
2.232	2.227	2.230	80000	1919650	8.46	8.39
2.251	2.248	2.249	80000	1927650	8.61	8.54
2.272	2.269	2.270	85000	1936150	8.77	8.69
2.291	2.289	2.290	75000	1943650	8.93	8.85
2.313	2.307	2.310	75000	1951150	9.10	9.02
2.333	2.326	2.330	72500	1958460	9.27	9.16
2.355	2.347	2.351	64000	1964660	9.45	9.36
2.374	2.368	2.371	62000	1971660	9.64	9.54
2.392	2.387	2.389	58000	1976860	9.81	9.72
2.412	2.406	2.409	56000	1982460	10.00	9.91
2.431	2.427	2.429	54000	1987860	10.20	10.10
2.453	2.448	2.450	65000	1994360	10.42	10.31
2.473	2.466	2.470	55000	1999860	10.63	10.52
2.493	2.486	2.489	55000	2005360	10.85	10.74
2.512	2.507	2.509	50000	2010160	11.08	10.96
2.532	2.527	2.530	50000	2015360	11.32	11.20

TABLE J33 CONTINUED

TR NUMBER: TR 515-450

CRACK LENGTH-A (INCH)			DELTA CYCLES		TOTAL CYCLES	DELTA K (KSI IN ^{-1/2})	AVERAGE DELTA K (KSI IN ^{-1/2})	DA/DN (INCH/CYCLE)
FRONT	BACK	AVERAGE	-	-				
2.554	2.549	2.551			5250	2020550	11.59	4.13E-06
2.576	2.566	2.571			4250	2024800	11.84	4.61E-06
2.592	2.588	2.590			3250	2028050	12.10	5.86E-06
2.613	2.613	2.613			5500	2033550	12.42	4.20E-06
2.634	2.627	2.630			4250	2037800	12.67	4.84E-06
2.654	2.648	2.651			4400	2042200	12.97	4.67E-06
2.676	2.665	2.671			4350	2046550	13.29	4.59E-06
2.696	2.686	2.691			4200	2050750	13.62	4.83E-06
2.715	2.706	2.710			4600	2054750	13.94	4.78E-06
2.733	2.728	2.731			3900	2058650	14.30	4.14E-06
2.753	2.748	2.751			3500	2062150	14.66	5.71E-06
2.773	2.767	2.770			3250	2065400	15.04	5.97E-06
2.793	2.787	2.790			4500	2069900	15.43	4.44E-06
2.814	2.806	2.810			4000	2073900	15.86	5.13E-06
2.833	2.827	2.830			2500	2076400	16.28	16.07
2.853	2.849	2.850			2500	2089000	16.75	8.28E-06
2.873	2.867	2.870			2100	2081000	17.22	9.38E-06
2.892	2.887	2.890			2500	2083500	17.71	17.47
2.913	2.906	2.910			2650	2086150	16.23	17.97
2.935	2.924	2.930			2900	2089050	16.78	16.51
2.951	2.954	2.953			2200	2091250	19.45	19.12
2.965	2.976	2.971			1600	2092850	20.89	19.73
2.991	2.999	2.995			2200	2095050	20.78	20.39
3.009	3.015	3.011			1950	2097000	21.32	21.05
3.036	3.031	3.034			1900	2098900	22.12	21.72
3.053	3.049	3.051			1200	2101000	22.79	22.46
3.073	3.066	3.070			1100	2101200	23.50	23.14
3.093	3.087	3.090			1150	2102350	24.34	23.92
3.111	3.107	3.109			1150	2103500	25.20	24.77
3.133	3.128	3.131			1200	2104700	26.20	25.70
3.153	3.146	3.149			900	2105600	27.11	26.66
3.180	3.174	3.177			700	2106360	28.59	27.85
3.196	3.196	3.203			400	2106760	30.06	29.32
3.209	3.209	3.203			175	2106935	30.72	30.39
3.220	3.207	3.214			200	2107135	31.78	31.25
3.235	3.225	3.230			200	2107335	33.08	32.43
3.253	3.246	3.249	**		200	2107535	34.54	9.55E-05
3.274	3.265	3.269	**		200	2107735	36.17	33.81
3.292	3.289	3.290	**		200	2107885	37.73	36.95
3.311	3.307	3.309	**		150	2107985	39.66	38.69
3.336	3.325	3.331	**		160	2108055	41.67	40.66
3.359	3.343	3.351	**		70	2108105	42.73	40.02E-04
3.368	3.362	3.371	**		50	2108105	43.78	

APPENDIX K

**2091-T3 and 2091-T8
0.144 Inch Sheet**

TABLE K1
TENSILE RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)		
MCDONNELL DOUGLAS ASTRO., CA	RT	LONG	59.4	49.0	20.0		11.4		
			60.1	49.2	20.0		11.6		
			59.9	49.5	20.0		11.5		
			59.9	49.6	20.0		11.5		
			58.9	49.5	22.0		11.5		
MARTIN MARIETTA, LA	RT	LONG	60.6	50.0	17.0	12.7	11.4		
			59.9	49.6	17.0	15.5	11.1		
			59.9	49.6	17.0	19.7	11.4		
AIR FORCE	RT	LONG	61.4	51.1	14.3	14.7			
			61.4	50.9	17.9	20.5			
			61.4	51.3	17.2	19.7			
AVERAGE			60.3	49.9	18.4	17.1	11.4		
STANDARD DEVIATION			0.8	0.8	2.2	3.2	0.1		

TABLE K2
TENSILE RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)		
AIR FORCE	RT	30	62.4	45.0	20.0	25.6			
			62.1	44.0	19.1	25.4			
			62.2	43.2	18.9	25.5			
AVERAGE			62.2	44.1	19.3	25.5			
STANDARD DEVIATION			0.2	0.9	0.6	0.1			

TABLE K3
TENSILE RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
AIR FORCE	RT	45	61.4	42.0	23.3	28.3	
			61.6	42.7	24.4	28.2	
			61.5	42.7	23.9	29.3	
		AVERAGE	61.5	42.5	23.9	28.6	
		STANDARD DEVIATION	0.1	0.4	0.6	0.6	

TABLE K4
TENSILE RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
AIR FORCE	RT	60	61.2	40.9	24.0	29.0	
			61.0	43.3	21.5	27.8	
			60.3	41.5	22.8	31.1	
		AVERAGE	60.8	41.9	22.8	29.3	
		STANDARD DEVIATION	0.5	1.2	1.3	1.7	

TABLE K5
TENSILE RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)		
MCDONNELL DOUGLAS ASTRO., CA	RT	L TRANS	64.3				12.0		
			65.3	46.6	14.0		11.6		
			65.2	46.6	14.0		11.6		
			64.3	46.4	12.5		11.5		
			64.6	46.7	12.5		11.6		
MARTIN MARIETTA, LA	RT	L TRANS	64.7	46.2	12.0	12.7	11.1		
			65.1	45.8	13.0	11.3	11.4		
			64.7	45.6	13.0	11.3	11.3		
AIR FORCE	RT	L TRANS	66.0	47.3	16.4	16.2			
			66.4	47.4	17.5	17.3			
			66.0	47.5	15.7	18.8			
AVERAGE			65.1	46.6	14.1	14.6	11.5		
STANDARD DEVIATION			0.7	0.6	1.9	3.3	0.3		

TABLE K6
TENSILE RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)		
MCDONNELL DOUGLAS ASTRO., CA	-320 F	LONG	75.3	57.6	16.0		12.4		
			76.2	58.1	16.5		12.5		
			75.1	57.4	17.0		12.5		
			75.0	58.0	17.0		12.5		
AVERAGE			75.4	57.8	16.6		12.5		
STANDARD DEVIATION			0.5	0.3	0.5		0.1		

TABLE K7
TENSILE RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
MCDONNELL DOUGLAS ASTRO., CA	-320 F	L TRANS	81.6 82.2 81.5 80.6	53.9 54.2 55.1 55.1	16.5 14.5 14.5 13.0		12.7 12.7 12.7 12.5
		AVERAGE	81.5	54.6	14.6		12.7
		STANDARD DEVIATION	0.7	0.6	1.4		0.1

TABLE K8
COMPRESSION RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)
MCDONNELL	RT	LONG	41.1	11.5
DOUGLAS				11.5
ASTRO., CA			40.7	11.4
		AVERAGE	40.9	11.5
		STANDARD DEVIATION	0.3	0.1

TABLE K9
COMPRESSION RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)
MCDONNELL	RT	L TRANS	49.0	11.3
DOUGLAS			48.6	11.5
ASTRO., CA			49.8	11.5
		AVERAGE	49.1	11.4
		STANDARD DEVIATION	0.6	0.1

TABLE K10
COMPRESSION RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)
MCDONNELL	-320 F	LONG	46.8	12.7
DOUGLAS				12.5
ASTRO., CA			46.4	12.4
		AVERAGE	46.6	12.5
		STANDARD DEVIATION	0.3	0.2

TABLE K11
COMPRESSION RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)
MCDONNELL	-320 F	L TRANS	56.8	12.8
DOUGLAS			55.1	12.8
ASTRO., CA			58.8	12.5
		AVERAGE	56.9	12.7
		STANDARD DEVIATION	1.9	0.2

TABLE K12
BEARING RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
MCDONNELL DOUGLAS ASTRO., CA	LONG	1.5	95.6 95.9 95.3 95.2 95.1	75.3 75.8 74.3 72.9
		AVERAGE	95.4	74.6
		STANDARD DEVIATION	0.3	1.3

TABLE K13
BEARING RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
MCDONNELL DOUGLAS ASTRO., CA	L TRANS	1.5	98.1 98.2 98.5 96.5 98.1	75.3 74.2 78.6 74.6
		AVERAGE	97.9	75.7
		STANDARD DEVIATION	0.8	2.0

TABLE K14
BEARING RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
MCDONNELL	LONG	2.0	119.0	86.2
DOUGLAS			119.0	
ASTRO., CA			120.0	86.6
			120.0	
			120.0	85.3
		AVERAGE	119.6	86.0
		STANDARD DEVIATION	0.5	0.7

TABLE K15
BEARING RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
MCDONNELL	L TRANS	2.0	122.0	89.2
DOUGLAS			122.0	90.7
ASTRO., CA			122.0	
			123.0	88.7
			121.0	87.9
		AVERAGE	122.0	89.1
		STANDARD DEVIATION	0.7	1.2

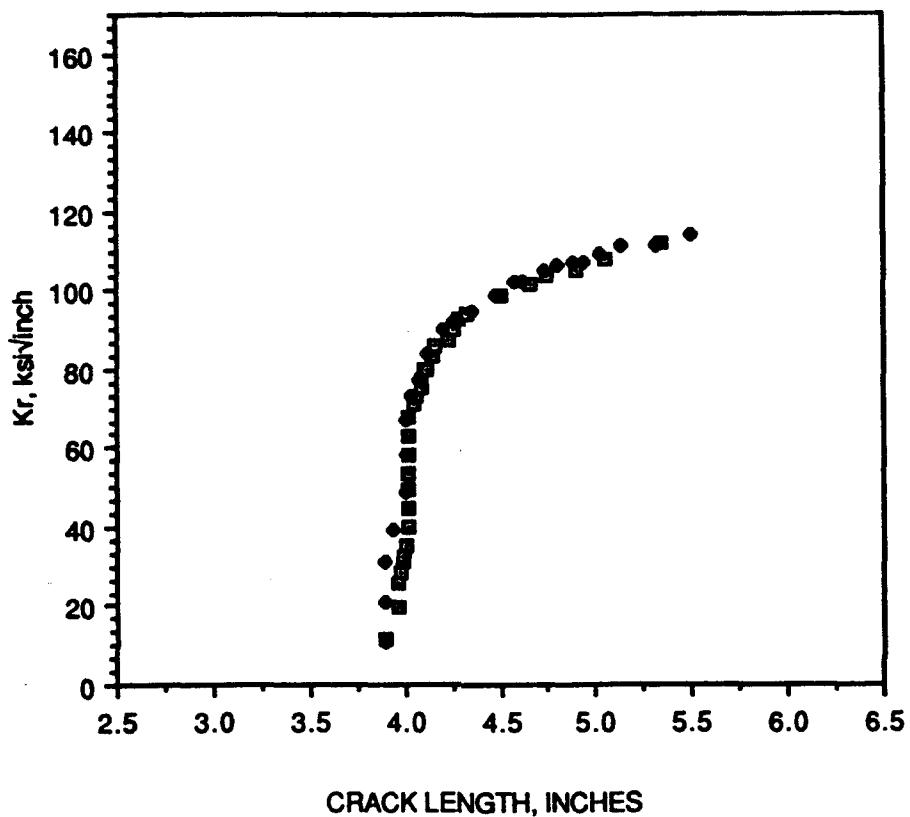


Figure K1. R-Curve Results for 2091-T3
0.144 Inch Sheet (L-T Orientation).
Martin Marietta

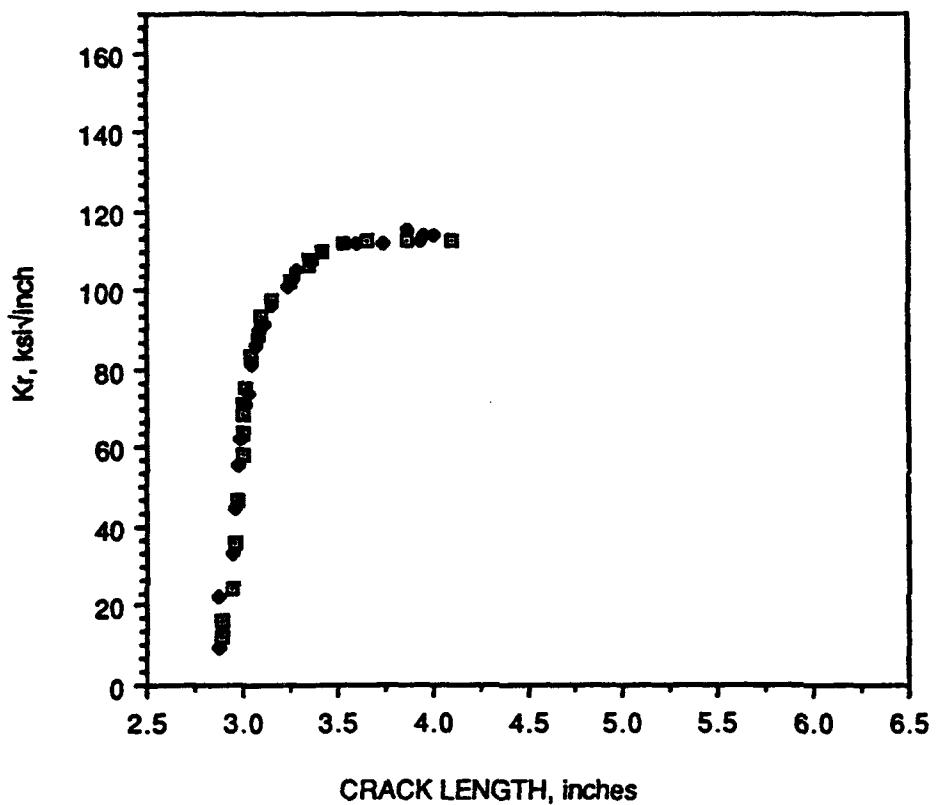


Figure K2. R-Curve Results for 2091-T3 0.144
Inch Sheet (T-L Orientation).
Martin Marietta.

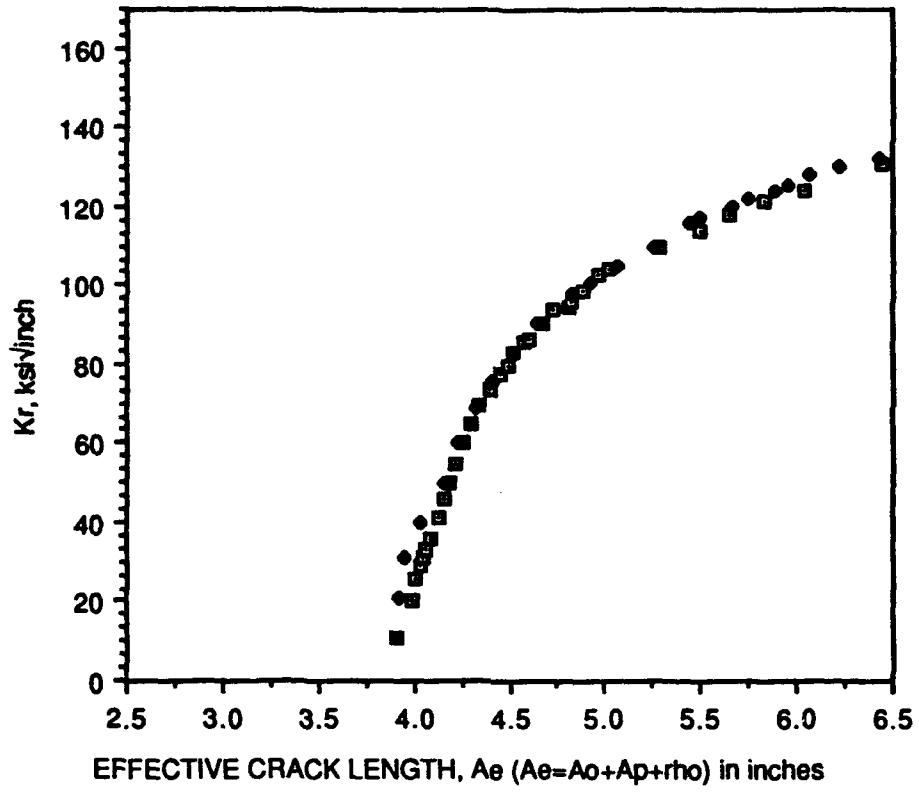


Figure K3. R-Curve Results for 2091-T3
0.144 Inch Sheet with Effective Crack Length
Adjusted for Plastic Zone (L-T Orientation)
Martin Marietta.

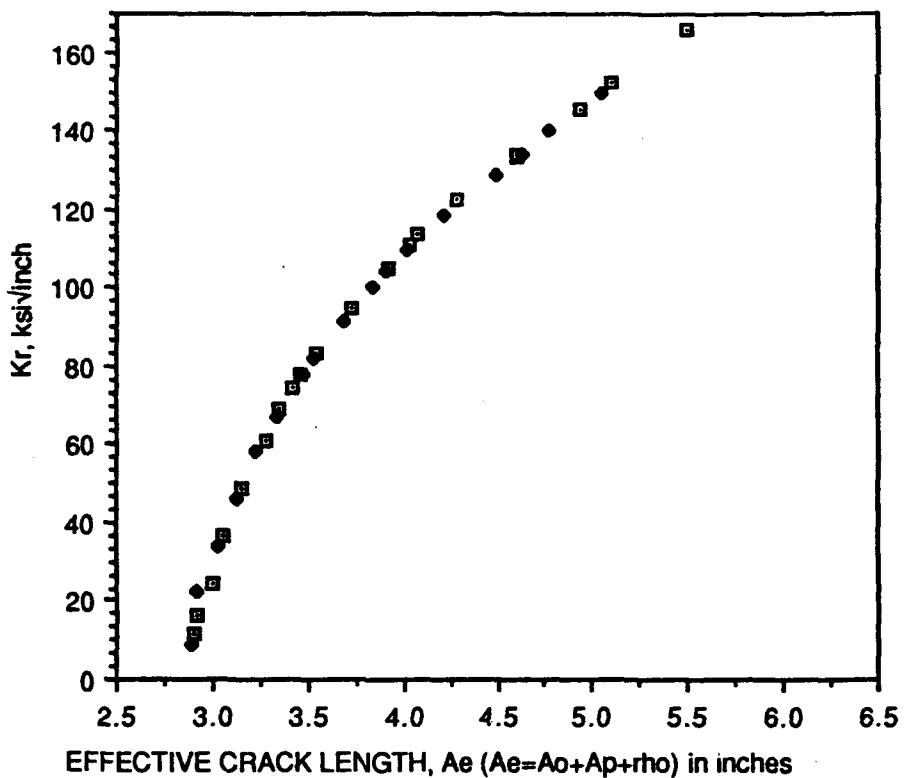


Figure K4. R-Curve Results for 2091-T3
0.144 Inch Sheet with Effective Crack Length
Adjusted for Plastic Zone (T-L Orientation)
Martin Marietta.

TABLE K16
R-CURVE DATA ASSOCIATED WITH
FIGURES K1 AND K3 (SPECIMEN 3)

Load, kips	Half Crack Length (c) inch	Half Crack Length, (c + rho) inch	Corresponding Fracture Toughness, ksi/inch	
			Not adjusted	Adjusted for Plasticity
10	3.895	3.902	11	11
18	3.960	3.985	20	20
24	3.960	4.004	26	26
26	3.975	4.029	29	29
28	3.990	4.053	31	31
29	3.990	4.059	32	33
32	4.000	4.083	36	36
36	4.020	4.126	40	41
40	4.020	4.154	45	46
44	4.020	4.183	49	50
48	4.020	4.213	53	55
52	4.020	4.251	58	60
57	4.020	4.295	63	65
61	4.020	4.340	68	70
64	4.045	4.402	71	74
65	4.060	4.451	73	78
67	4.085	4.497	75	80
69	4.085	4.525	77	83
71	4.105	4.581	80	86
71	4.115	4.601	80	87
74	4.140	4.668	84	91
74	4.140	4.677	84	91
76	4.165	4.732	86	94
76	4.225	4.812	88	95
76	4.225	4.823	88	96
78	4.255	4.886	90	99
80	4.290	4.967	93	103
81	4.325	5.027	94	104
82	4.500	5.284	99	110
82	4.655	5.495	102	114
83	4.750	5.649	104	118
82	4.900	5.837	105	121
82	5.045	6.042	108	124
81	5.345	6.447	112	131

Thickness = .144 inch
Yield = 49.7 ksi
Specimen Width = 23.83 inch

TABLE K17
R-CURVE DATA ASSOCIATED WITH
FIGURES K1 AND K3 (SPECIMEN 4)

Load, kips	Half Crack Length (c) inch	Half Crack Length, (c + rho) inch	Corresponding Fracture Toughness, ksi $\sqrt{\text{inch}}$	
			Not adjusted	Adjusted for Plasticity
10	3.895	3.902	11	11
19	3.895	3.924	21	21
28	3.895	3.956	31	31
36	3.930	4.032	39	40
44	4.000	4.163	49	50
52	4.000	4.231	58	60
60	4.010	4.319	67	69
65	4.040	4.416	73	76
69	4.080	4.523	77	83
74	4.110	4.641	84	91
78	4.200	4.823	90	98
79	4.260	4.921	92	101
80	4.350	5.058	95	105
82	4.480	5.262	99	110
84	4.575	5.440	102	116
84	4.615	5.492	102	117
84	4.735	5.663	105	120
84	4.800	5.754	106	122
84	4.890	5.883	107	124
84	4.945	5.956	107	125
84	5.025	6.072	109	128
84	5.135	6.223	111	130
82	5.320	6.435	111	132
81	5.490	6.661	114	135
79	5.730	6.962	115	138
74.5	6.265	7.660	117	144
74.5	6.440	7.932	118	152

Thickness = .144 inch
Yield = 49.7 ksi
Specimen Width = 23.81 inch

TABLE K18
R-CURVE DATA ASSOCIATED WITH
FIGURES K2 AND K4 (SPECIMEN 1)

Load, kips	Half Crack Length (c) inch	Half Crack Length, (c + rho) inch	Corresponding Fracture Toughness, ksi $\sqrt{\text{inch}}$	
			Not adjusted	Adjusted for Plasticity
10	2.895	2.905	12	12
13	2.895	2.915	16	16
19	2.950	2.995	24	25
28	2.960	3.061	36	36
37	2.980	3.158	47	49
46	2.995	3.279	58	61
50	2.995	3.354	64	69
54	3.000	3.422	69	75
56	3.005	3.461	71	78
59	3.020	3.547	75	83
65	3.045	3.728	83	95
69	3.085	3.920	89	105
71	3.100	4.032	92	111
72	3.100	4.077	94	114
75	3.150	4.282	98	122
76	3.250	4.598	102	133
77	3.250	4.608	102	134
78	3.345	4.943	106	145
79	3.355	5.104	108	152
79	3.420	5.500	110	166
79	3.525		112	
77	3.655		113	
75	3.865		113	
71	4.100		113	

Thickness = .144 inch
Yield = 45.9 ksi
Specimen Width = 18.03 inch

TABLE K19
R-CURVE DATA ASSOCIATED WITH
FIGURES K2 AND K4 (SPECIMEN 2)

Load, kips	Half Crack Length (c) inch	Half Crack Length, (c + rho) inch	Corresponding Fracture Toughness, ksi $\sqrt{\text{inch}}$	
			Not adjusted	Adjusted for Plasticity
8	2.880	2.886	10	9
18	2.880	2.918	22	22
26	2.950	3.036	33	34
36	2.950	3.122	45	46
44	2.975	3.231	56	58
49	2.990	3.331	63	67
56	3.020	3.477	71	78
58	3.025	3.530	74	82
63	3.050	3.687	81	92
67	3.075	3.837	86	100
68	3.080	3.901	88	104
70	3.115	4.025	92	110
73	3.150	4.214	96	119
75	3.240	4.499	101	129
76	3.260	4.627	103	134
78	3.275	4.766	105	140
78	3.365	5.054	107	149
79	3.425		110	
79	3.425		110	
78	3.540		112	
78	3.605		112	
76	3.735		112	
75	3.865		115	
73	3.940		113	
74	3.955		114	
73	4.000		114	

Thickness = .144 inch
Yield = 45.9 ksi
Specimen Width = 18.01 inch

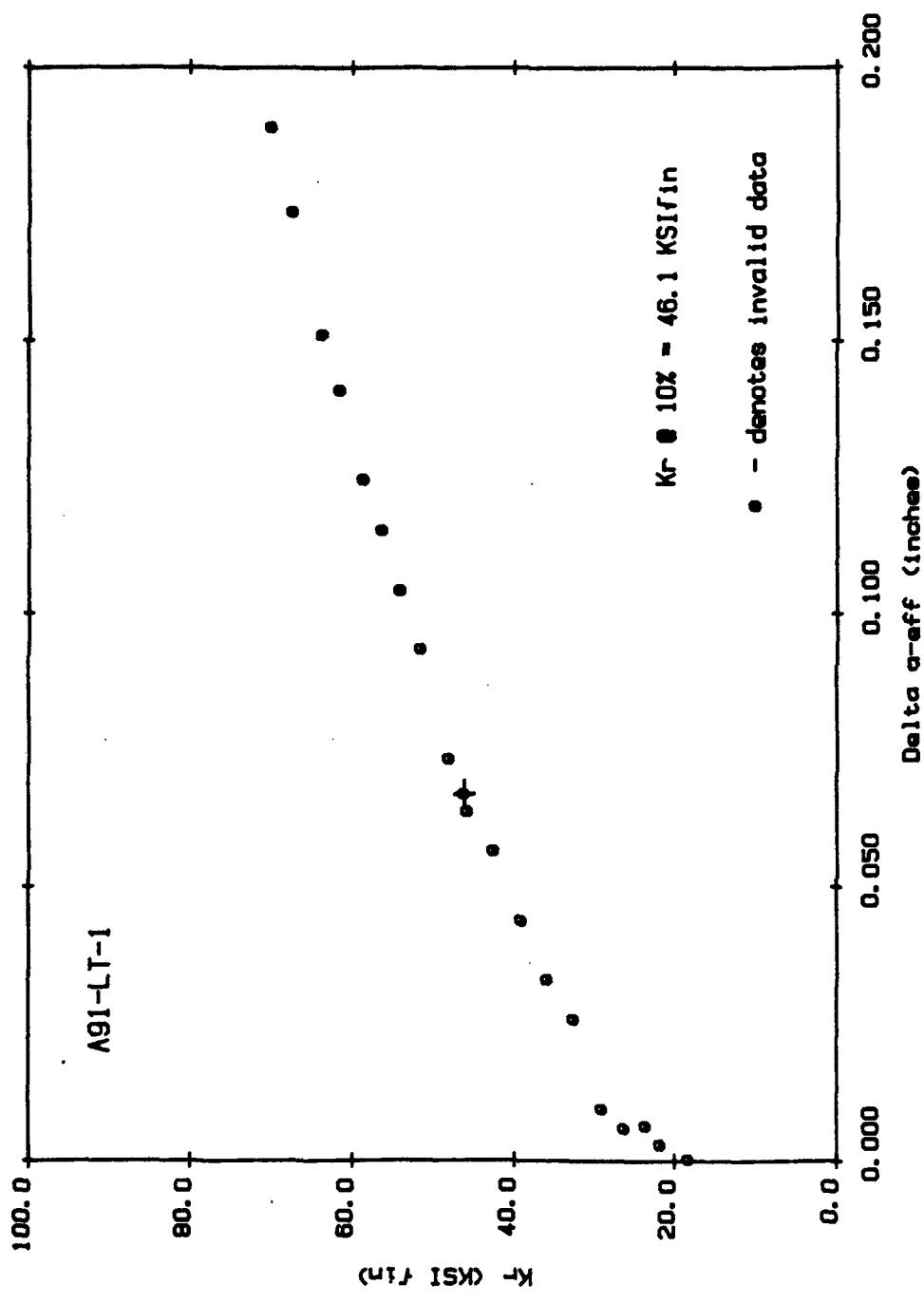


FIGURE K5.
 R-CURVE RESULTS FOR 2091-T3 0.144 INCH
 SHEET (L-T ORIENTATION),
 AIR FORCE.

TABLE K20
R-CURVE DATA ASSOCIATED WITH
FIGURE K5 (L-T ORIENTATION)

A91-LT-1 Oct 7, 1968
 W = 2.509 inches
 B = 0.143 inches
 E = 12.760 MSI
 VS = 51.000 KSI
 Initial a (physical) = 1.046 inches
 Initial a (compliance) = 1.044 inches

POINT	2V	P (LBF)	EB2V/P	a-eff/W	R _r	a-eff	delta a
*** Initial compliance crack length ***							
1	0.0116	542	42.57	0.4160	18.22	1.0438	0.0003
2	0.0140	645	42.74	0.4171	21.74	1.0465	0.0030
3	0.0153	696	42.95	0.4185	23.57	1.0500	0.0064
4	0.0172	775	42.92	0.4183	26.22	1.0495	0.0060
5	0.0191	854	43.14	0.4197	29.01	1.0530	0.0095
6	0.0218	942	44.17	0.4262	32.57	1.0694	0.0258
7	0.0241	1029	44.64	0.4291	35.87	1.0767	0.0331
8	0.0265	1109	45.34	0.4334	39.10	1.0874	0.0438
9	0.0292	1192	46.21	0.4385	42.61	1.1002	0.0566
10	0.0315	1271	46.70	0.4413	45.79	1.1074	0.0638
11	0.0333	1321	47.37	0.4452	48.13	1.1170	0.0734
12	0.0360	1384	48.82	0.4532	51.57	1.1371	0.0935
13	0.0380	1434	49.62	0.4575	54.08	1.1479	0.1043
14	0.0398	1475	50.46	0.4619	56.34	1.1589	0.1153
15	0.0416	1518	51.19	0.4656	58.59	1.1683	0.1247
16	0.0440	1564	52.51	0.4722	61.52	1.1847	0.1411
17	0.0459	1603	53.35	0.4762	63.81	1.1949	0.1513
18	0.0490	1651	55.26	0.4851	67.47	1.2172	0.1736
19	0.0512	1682	56.64	0.4913	70.04	1.2326	0.1890
20	0.0565	1738	60.36	0.5068	75.90	1.2717	0.2281
21	0.0597	1762	62.84	0.5165	79.32	1.2959	0.2523
22	0.0660	1792	68.12	0.5353	85.79	1.3430	0.2994

The following value is the 10% SECANT value
 23 0.0318 1275 46.92 0.4426 46.10 1.1105 0.0670

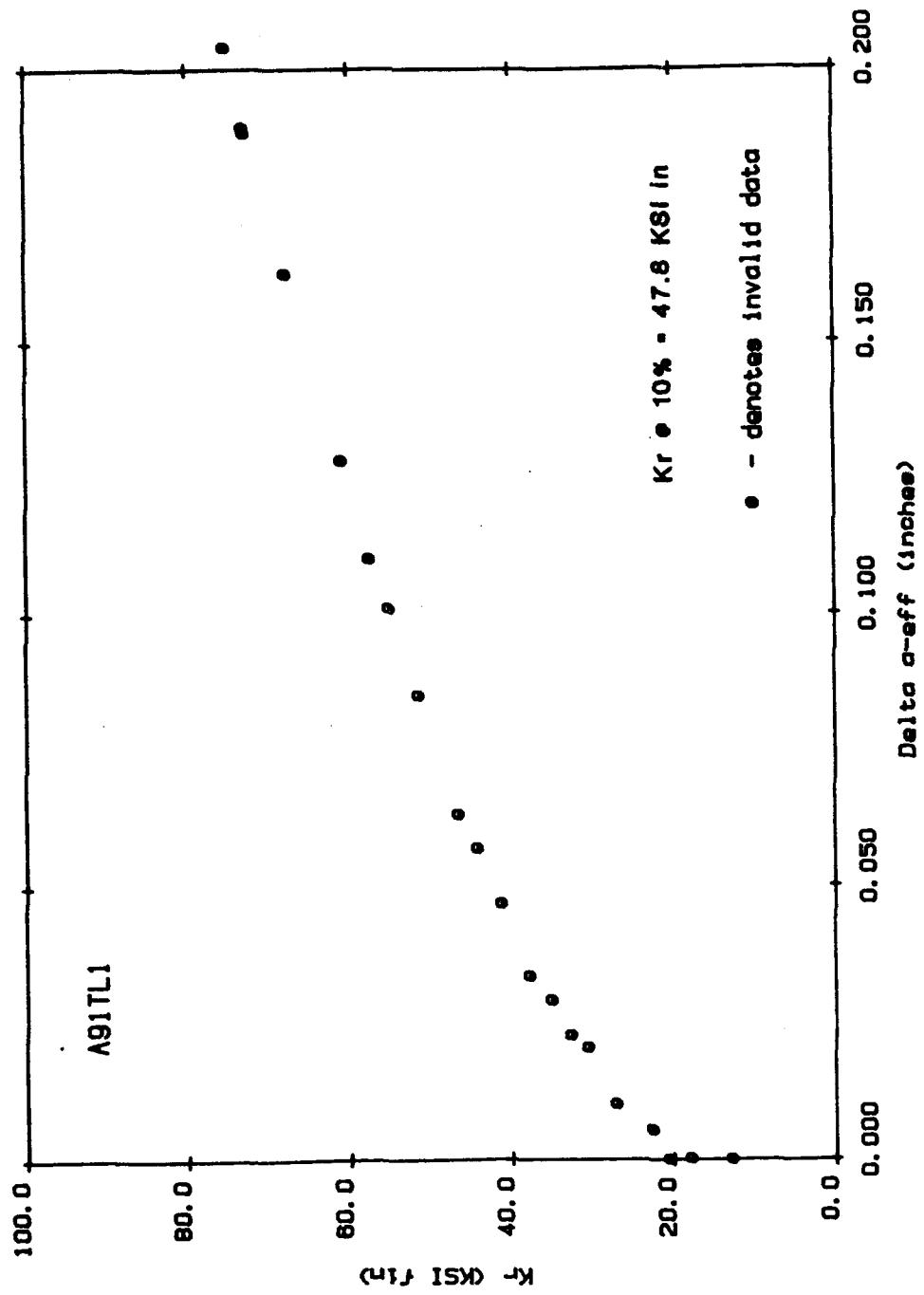


FIGURE K6. R-CURVE RESULTS FOR 2091-T3
0.144 INCH SHEET (T-L Orientation).
AIR FORCE.

TABLE K21
R-CURVE DATA ASSOCIATED WITH
FIGURE K6 (T-L ORIENTATION)

A91TL1 Oct 6, 1988
 $W = 2.504$ inches
 $B = 0.143$ inches
 $E = 12.520$ MSI
 $Y_S = 55.000$ KSI
 Initial a (physical) = 1.048 inches
 Initial a (compliance) = 1.046 inches

POINT	2V	P (LBF)	EB2V/P	a_{eff}/W	R _r	a_{eff}	delta a
*** initial compliance crack length ***							
1	0.0080	381	42.68	0.4167	12.82	1.0433	-0.0023
2	0.0116	528	42.84	0.4177	17.82	1.0459	0.0002
3	0.0135	608	42.81	0.4175	20.48	1.0453	-0.0003
4	0.0150	665	43.16	0.4198	22.56	1.0511	0.0054
5	0.0182	792	43.45	0.4217	26.99	1.0558	0.0101
6	0.0207	882	44.11	0.4258	30.41	1.0661	0.0205
7	0.0222	943	44.25	0.4267	32.58	1.0684	0.0227
8	0.0240	1005	44.67	0.4293	34.97	1.0747	0.0291
9	0.0260	1076	44.96	0.4311	37.64	1.0792	0.0335
10	0.0287	1161	45.84	0.4364	41.21	1.0925	0.0468
11	0.0309	1230	46.54	0.4404	44.14	1.1026	0.0570
12	0.0327	1286	46.97	0.4429	46.47	1.1089	0.0632
13	0.0366	1388	48.54	0.4517	51.40	1.1308	0.0851
14	0.0395	1460	49.73	0.4581	55.05	1.1468	0.1012
15	0.0414	1507	50.43	0.4617	57.41	1.1559	0.1103
16	0.0442	1564	51.85	0.4689	60.86	1.1739	0.1283
17	0.0499	1669	54.71	0.4826	67.59	1.2082	0.1626
18	0.0544	1740	57.11	0.4933	72.76	1.2350	0.1894
19	0.0565	1762	58.49	0.4992	75.02	1.2498	0.2041
20	0.0607	1797	61.56	0.5116	79.53	1.2808	0.2351
21	0.0643	1781	66.18	0.5286	83.23	1.3234	0.2778
22	0.0704	1745	73.25	0.5516	88.15	1.3810	0.3353
23	0.0754	1738	78.78	0.5674	92.78	1.4205	0.3749

The following value is the 25% SECANT value
 24 0.0543 1738 57.02 0.4929

The following value is the 10% SECANT value
 24 0.0543 1738 57.02 0.4929

0.0339 1314 47.48 0.4458 47.82 1.1161 0.0705

0.1684 invalid

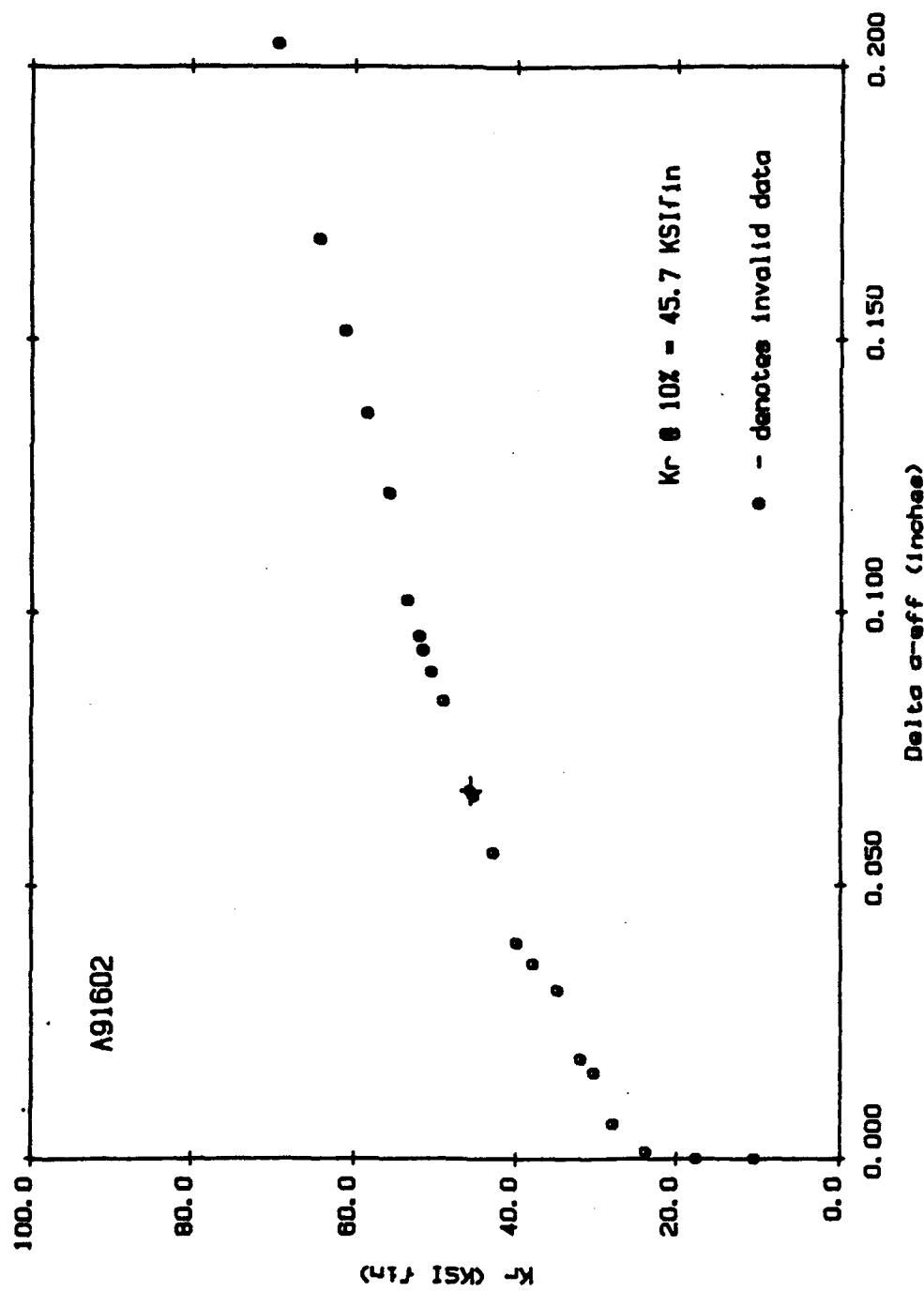


FIGURE K7. R-CURVE RESULTS for 2091-T3 0.144 Inch Sheet
 (60° Orientation, Specimen 1).
 Air Force.

TABLE K22

R-CURVE DATA ASSOCIATED WITH
FIGURE K7 (60° ORIENTATION, SPECIMEN 1)

A91602 Oct 7, 1998
 $W = 2.506$ inches
 $B = 0.143$ inches
 $E = 12.450$ MSI
 $YS = 50.000$ KSI
Initial ϵ (Physical) = 1.109 inches
Initial a (compliance) = 1.106 inches

POINT	2V	P (LB/P)	EB2V/P	$\epsilon - \epsilon_{eff}/W$	Kr	$\epsilon - \epsilon_{eff}$	delta a
*** Initial compliance crack length ***							
1	0.0063	292	46.08	0.4378	10.39	1.0968	-0.0097
2	0.0115	489	46.35	0.4393	17.49	1.1007	-0.0059
3	0.0161	656	46.83	0.4421	23.66	1.1077	0.0012
4	0.0190	764	47.19	0.4442	27.70	1.1129	0.0064
5	0.0209	821	47.86	0.4479	30.10	1.1222	0.0157
6	0.0222	866	48.04	0.4489	31.82	1.1247	0.0183
7	0.0244	930	48.95	0.4539	34.68	1.1372	0.0307
8	0.0268	1011	49.31	0.4558	37.87	1.1420	0.0355
9	0.0283	1060	49.59	0.4573	39.89	1.1458	0.0393
10	0.0301	1116	50.86	0.4639	42.82	1.1623	0.0558
11	0.0327	1168	51.64	0.4681	45.34	1.1728	0.0663
12	0.0357	1238	53.10	0.4750	49.03	1.1902	0.0837
13	0.0377	1284	53.89	0.4788	51.45	1.1996	0.0931
14	0.0369	1266	53.55	0.4772	50.47	1.1955	0.0890
15	0.0381	1293	54.11	0.4798	51.93	1.2021	0.0956
16	0.0394	1321	54.67	0.4824	53.48	1.2087	0.1022
17	0.0414	1343	56.42	0.4903	55.69	1.2284	0.1219
18	0.0437	1384	57.76	0.4961	58.41	1.2430	0.1365
19	0.0461	1422	59.20	0.5021	61.10	1.2580	0.1516
20	0.0488	1463	60.86	0.5088	64.21	1.2749	0.1684
21	0.0536	1508	64.64	0.5231	69.27	1.3106	0.2042
22	0.0605	1530	71.77	0.5471	76.10	1.3706	0.2642
23	0.0680	1515	81.30	0.5741	82.92	1.4384	0.3319
The following value is the 10 ⁸ SECANT value							
24	0.0330	1175	51.76	0.4684	45.67	1.1737	0.0672

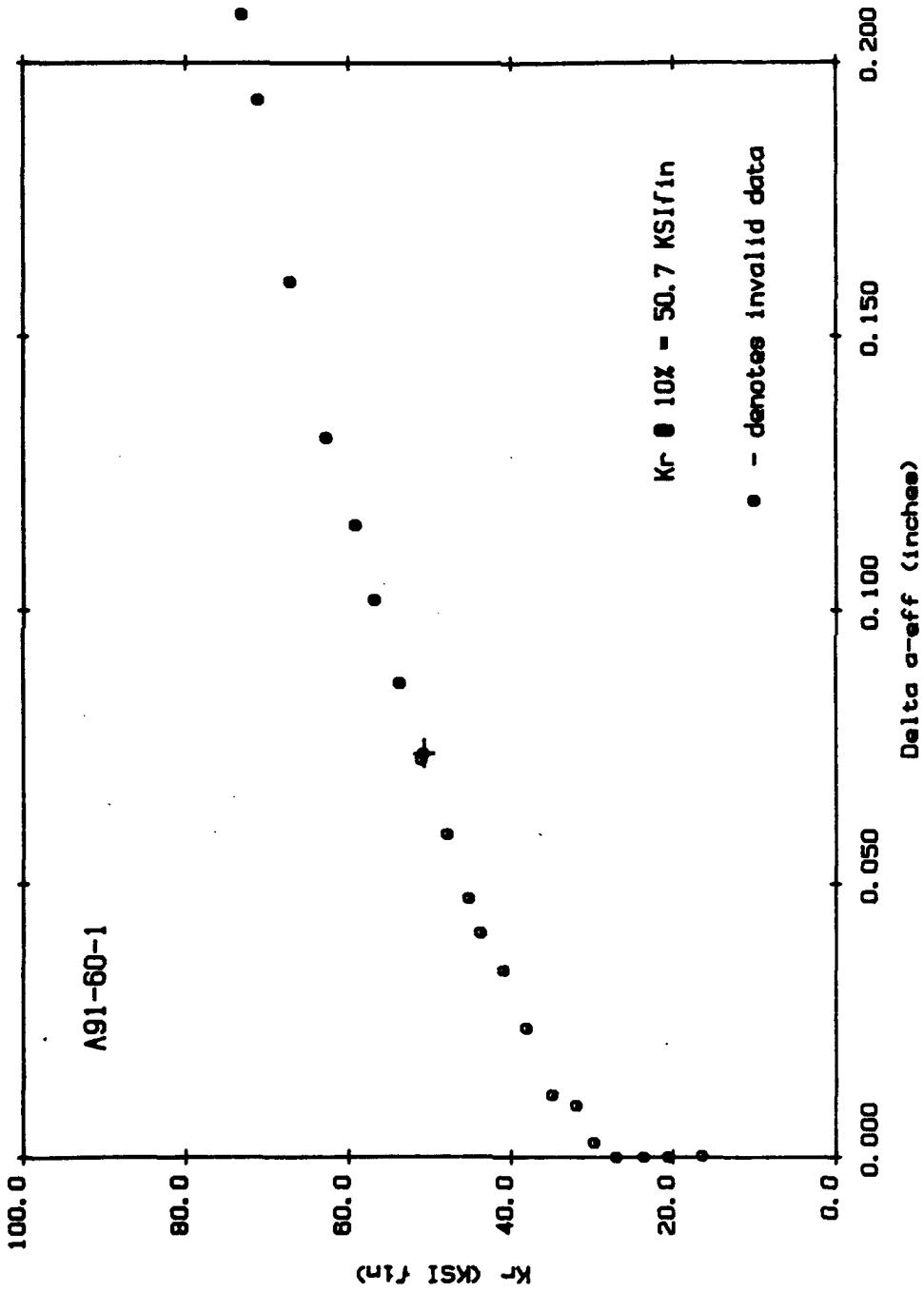


FIGURE K8. R-CURVE RESULTS FOR 2091-T3
0.144 INCH SHEET (60° ORIENTATION,
SPECIMEN 2). AIR FORCE

TABLE K23

R-CURVE DATA ASSOCIATED WITH FIGURE K8
(60° ORIENTATION, SPECIMEN 2)

A91-60-1 Oct 7, 1988
 W = 2.508 inches
 B = 0.143 inches
 E = 11.980 MSI
 YS = 50.000 KSI
 Initial a (physical) = 1.036 inches
 Initial a (compliance) = 1.034 inches

POINT	2V	P (LB/P)	EB2V/P	a-eff/W	R/ R _f	a-eff	delta a
*** initial compliance crack length ***							
1	0.0106	493	42.05	0.4125	16.32	1.0343	0.0002
2	0.0136	622	41.66	0.4099	20.46	1.0346	-0.0063
3	0.0159	709	42.03	0.4124	23.49	1.0342	-0.0001
4	0.0184	815	41.84	0.4112	26.92	1.0311	-0.0032
5	0.0205	893	42.19	0.4135	29.67	1.0369	0.0026
6	0.0222	952	42.60	0.4162	31.86	1.0438	0.0095
7	0.0244	1038	42.72	0.4170	34.80	1.0457	0.0114
8	0.0269	1119	43.48	0.4218	38.03	1.0579	0.0236
9	0.0291	1189	44.15	0.4261	40.85	1.0685	0.0342
10	0.0313	1263	44.59	0.4288	43.73	1.0753	0.0410
11	0.0325	1294	45.00	0.4313	45.13	1.0816	0.0473
12	0.0346	1354	45.77	0.4359	47.80	1.0933	0.0590
13	0.0372	1421	46.71	0.4414	50.96	1.1070	0.0727
14	0.0394	1472	47.69	0.4470	53.60	1.1210	0.0867
15	0.0421	1533	48.80	0.4531	56.77	1.1362	0.1019
16	0.0441	1570	49.82	0.4585	59.09	1.1499	0.1156
17	0.0471	1636	51.05	0.4649	62.66	1.1658	0.1315
18	0.0512	1696	53.35	0.4762	67.17	1.1943	0.1600
19	0.0550	1725	56.24	0.4895	71.07	1.2276	0.1933
20	0.0569	1740	57.68	0.4957	73.03	1.2432	0.2089
21	0.0571	1765	76.54	0.5612	91.85	1.4074	0.3731
The following value is the 10% SECANT value							
22	0.0370	1411	46.79	0.4419	50.66	1.1081	0.0738

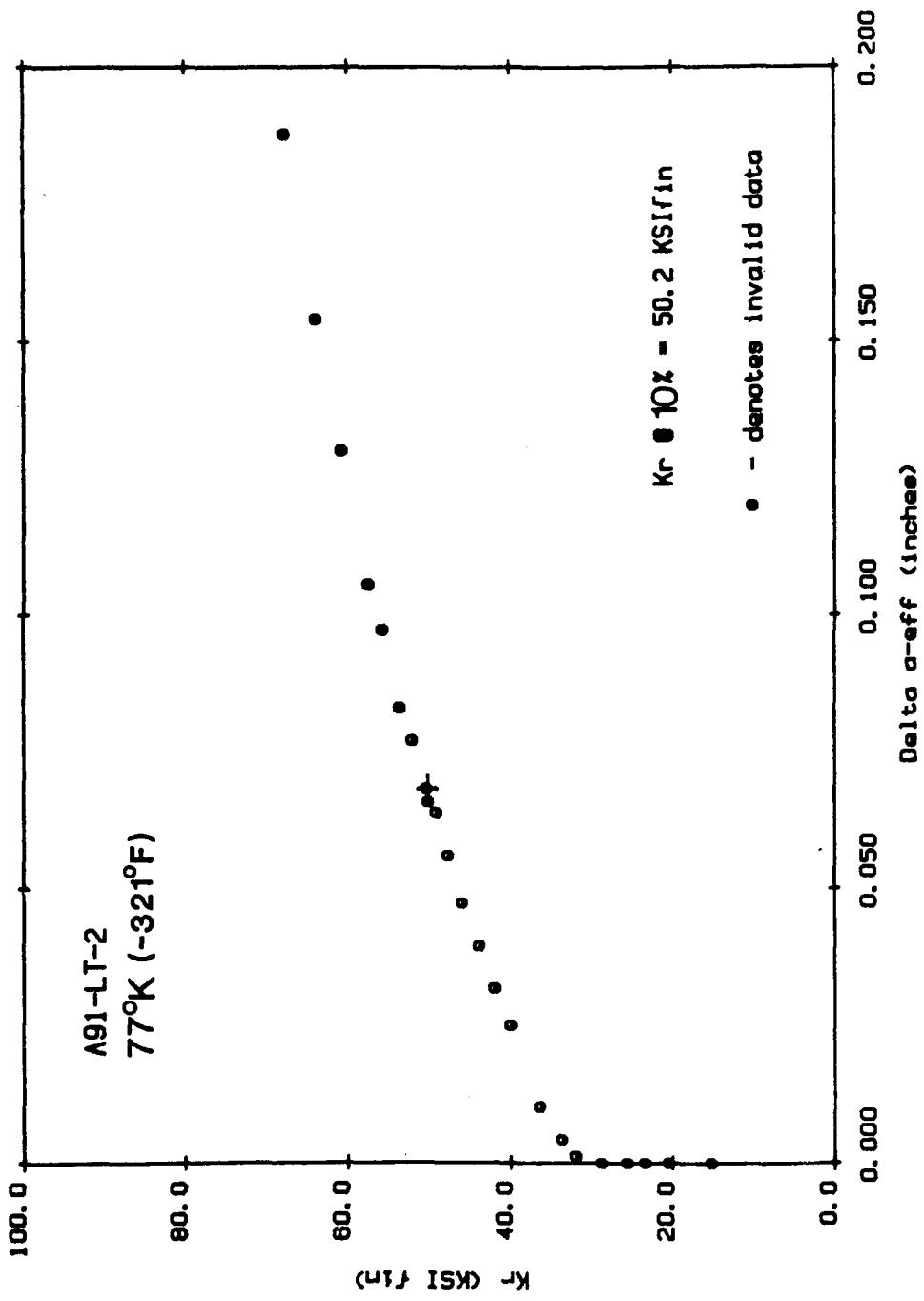


FIGURE K9. R-CURVE RESULTS FOR 2091-T3
0.144 INCH SHEET (L-T ORIENTATION,
-321°F), AIR FORCE.

TABLE K24

R-CURVE DATA ASSOCIATED WITH FIGURE K9
(L-ORIENTATION, -321°F)

A91-LT-2 7 Oct, 1988
 W = 2.501 inches
 B = 0.144 inches
 E = 13.690 MSI
 YS = 51.000 KSI
 Initial a (physical) = 1.031 inches
 Initial a (compliance) = 1.029 inches

POINT	2V	P (LB/P)	EB2V/P	a-eff/W	Kr	a-eff	delta a
*** Initial compliance crack length ***							
1	0.0074	567	42.35	0.4146	12.09	1.0287	-0.0009
2	0.0088	460	41.75	0.4105	15.15	1.0266	-0.0021
3	0.0121	624	41.34	0.4078	20.38	1.0197	-0.0089
4	0.0140	708	41.69	0.4102	23.27	1.0257	-0.0030
5	0.0154	778	41.47	0.4087	25.49	1.0219	-0.0067
6	0.0175	872	41.62	0.4097	28.64	1.0244	-0.0043
7	0.0196	965	41.94	0.4118	31.89	1.0299	0.0012
8	0.0207	1014	42.12	0.4130	33.59	1.0328	0.0042
9	0.0225	1089	42.49	0.4154	36.32	1.0389	0.0102
10	0.0250	1178	43.40	0.4214	39.91	1.0537	0.0251
11	0.0264	1228	43.83	0.4241	41.91	1.0604	0.0318
12	0.0277	1272	44.33	0.4272	43.81	1.0682	0.0396
13	0.0292	1323	44.84	0.4303	45.93	1.0761	0.0474
14	0.0304	1359	45.41	0.4338	47.65	1.0846	0.0561
15	0.0314	1387	45.94	0.4369	49.05	1.0925	0.0639
16	0.0321	1412	46.07	0.4377	50.04	1.0945	0.0659
17	0.0335	1449	46.85	0.4422	52.01	1.1058	0.0771
18	0.0346	1481	47.27	0.4446	53.50	1.1117	0.0831
19	0.0362	1515	48.29	0.4503	55.61	1.1260	0.0973
20	0.0375	1550	48.89	0.4536	57.43	1.1342	0.1056
21	0.0402	1594	50.76	0.4634	60.74	1.1587	0.1301
22	0.0427	1630	52.67	0.4729	63.84	1.1826	0.1540
23	0.0459	1660	55.56	0.4865	67.66	1.2164	0.1878
24	0.0491	1678	58.69	0.5000	71.29	1.2504	0.2217
25	0.0548	1678	65.36	0.5257	77.31	1.3146	0.2859
26	0.0564	1651	68.39	0.5362	78.74	1.3408	0.3121

The following value is the 10% SECANT value
 27 0.0322 1412 46.24 0.4387

27 0.0322 1412 46.24 0.4387

27 0.0322 1412 46.24 0.4387

27 0.0322 1412 46.24 0.4387

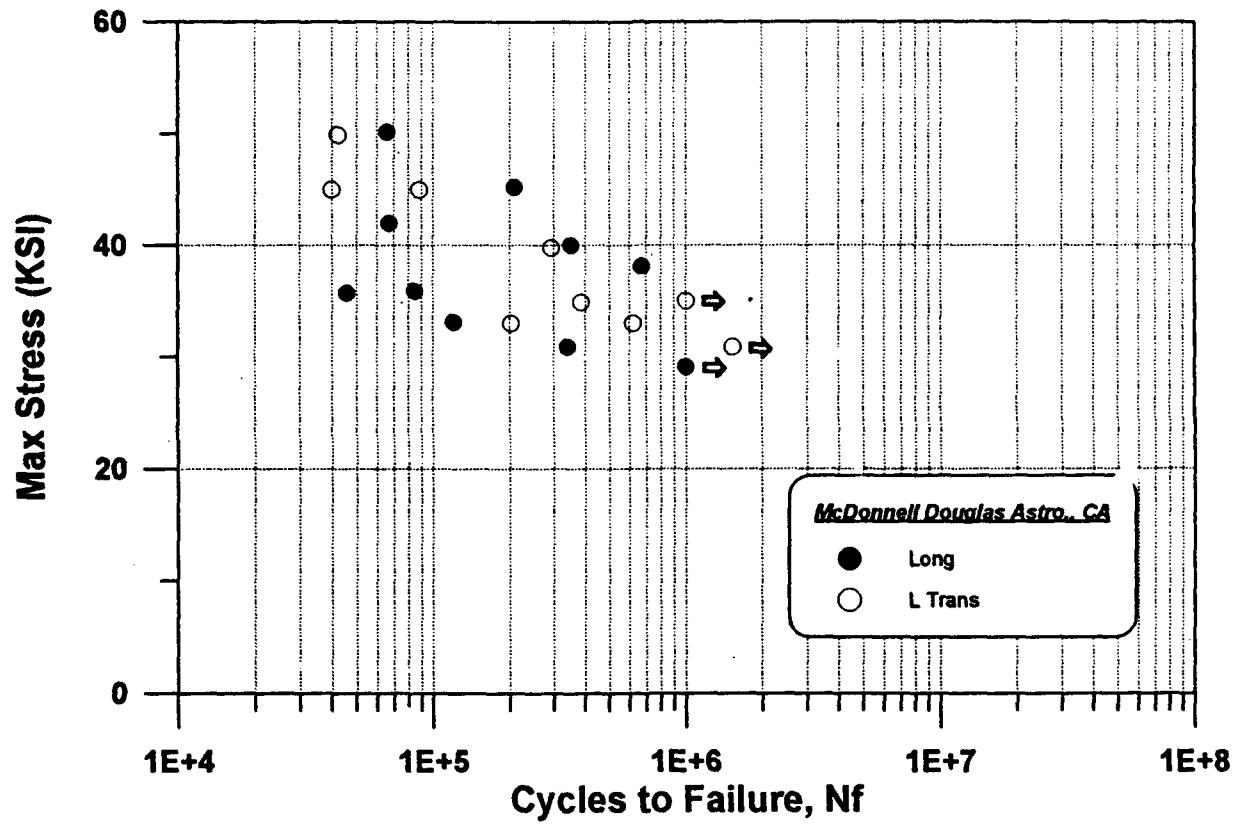


FIGURE K10. FATIGUE RESULTS FOR 2091-T3
0.144 INCH SHEET ($R=1.0$, $K_t = 1.0$).
MCDONNELL DOUGLAS ASTRONAUTICS

TABLE K25

FATIGUE RESULTS WITH R=0.1 AND KT=1.0 FOR
ALCOA 2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	ORIENTATION	STRESS (KSI)	CYCLES
MCDONNELL DOUGLAS ASTRO., CA	LONG	50.2	65,600 +
		45.2	209,000 +
		42.0	67,000
		40.0	353,000 +
		38.1	670,000 +
		35.9	84,400 @
		35.7	45,700 #
		33.1	120,000 @
		30.9	340,000
		29.1	1,000,000 *

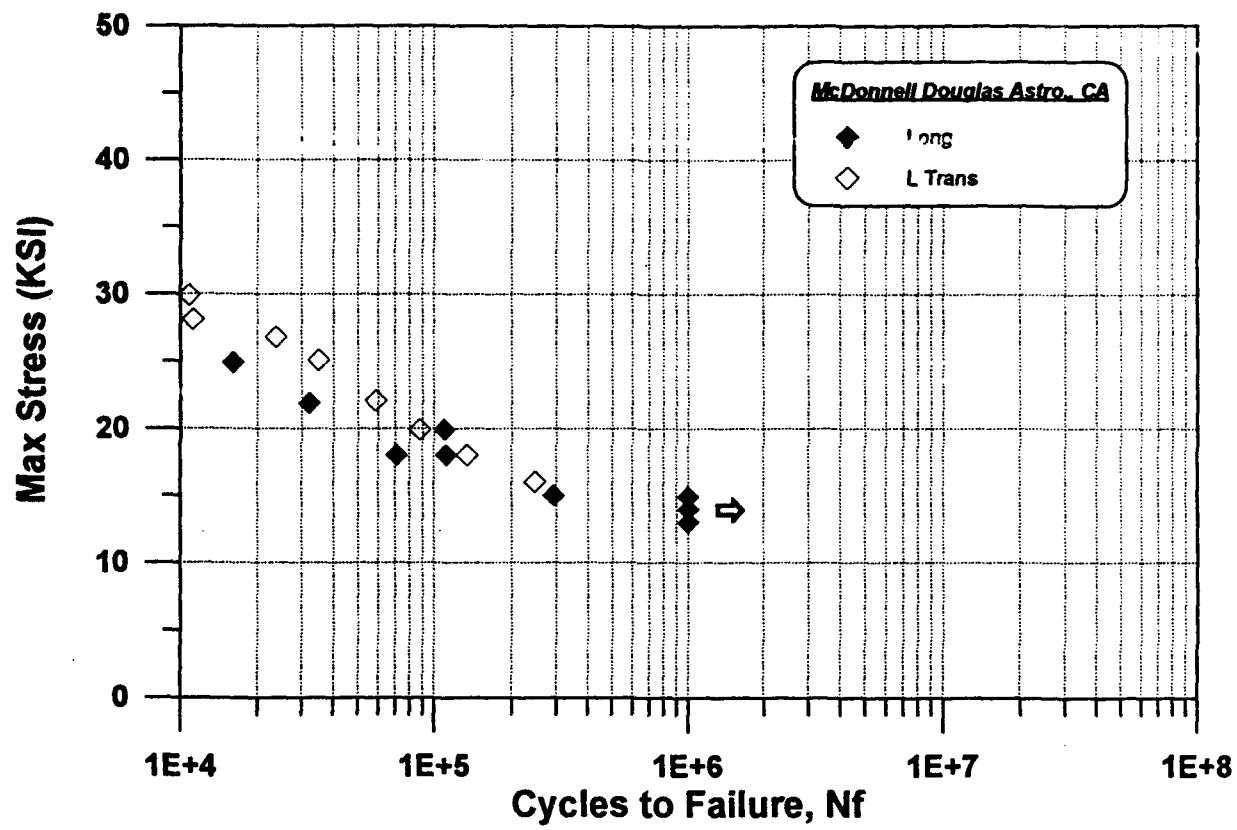
(*) : INDICATES A RUN-OUT TEST
(#) : INDICATES FAILURE AT PIN HOLE
(@) : INDICATES FAILURE AT RADIUS
(+) : INDICATES SPECIMENS WERE RECONFIGURED AND
HAD SURFACE COATING REMOVED

TABLE K26

FATIGUE RESULTS WITH R=0.1 AND KT=1.0 FOR
ALCOA 2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	ORIENTATION	STRESS (KSI)	CYCLES
MCDONNELL DOUGLAS ASTRO., CA	L TRANS	49.9	42,300 +
		45.0	87,700 #+
		45.0	39,900
		39.8	293,000 +
		35.0	1,000,000 **
		34.9	385,000 !
		33.0	203,000 !
		33.0	621,000 !
		30.9	1,530,000 *!

(*) : INDICATES A RUN-OUT TEST
(#) : INDICATES FAILURE AT PIN HOLE
(!) : INDICATES THE SPECIMENS WERE ONLY RECONFIGURED
(+) : INDICATES SPECIMENS WERE RECONFIGURED AND
HAD SURFACE COATING REMOVED



**FIGURE K11. FATIGUE RESULTS FOR 2091-T3
0.144 INCH SHEET ($R=1.0$, $K_t=3.0$).
MCDONNELL DOUGLAS ASTRONAUTICS**

TABLE K27
FATIGUE RESULTS WITH R=0.1 AND Kt=3.0 FOR
ALCOA 2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	ORIENTATION	STRESS (KSI)	CYCLES
MCDONNELL DOUGLAS ASTRO., CA	LONG	24.9	16,100
		21.9	32,200
		19.9	109,000
		18.0	112,000
		18.0	71,250
		15.0	294,000
		14.9	1,000,000 *
		14.0	1,000,000 *
		13.0	1,000,000 *

(*) : INDICATES A RUN-OUT TEST

TABLE K28
FATIGUE RESULTS WITH R=0.1 AND Kt=3.0 FOR
ALCOA 2091-T3 SHEET (0.144" X 48" X 48")

COMPANY	ORIENTATION	STRESS (KSI)	CYCLES
MCDONNELL DOUGLAS ASTRO., CA	L TRANS	29.9	10,800
		28.1	11,200
		26.8	23,700
		25.1	34,900
		22.1	58,700
		19.9	87,400
		18.0	135,000
		16.0	247,000
		14.9	1,000,000

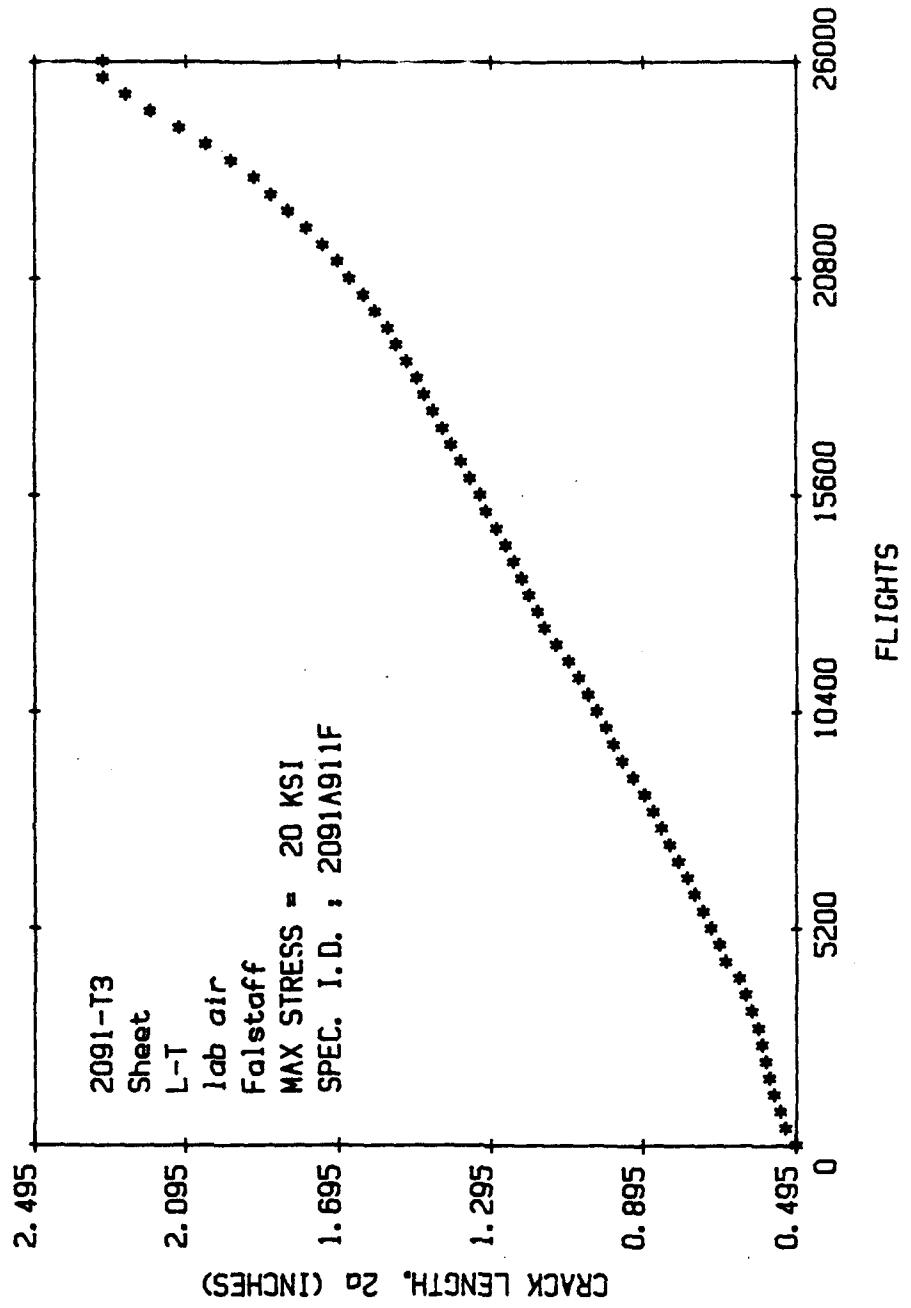


FIGURE K12. FALSTAFF SPECTRUM FATIGUE CRACK LENGTH
 VS FLIGHTS DATA FOR 2091-T3 0.144
 INCH SHEET, AIR FORCE.

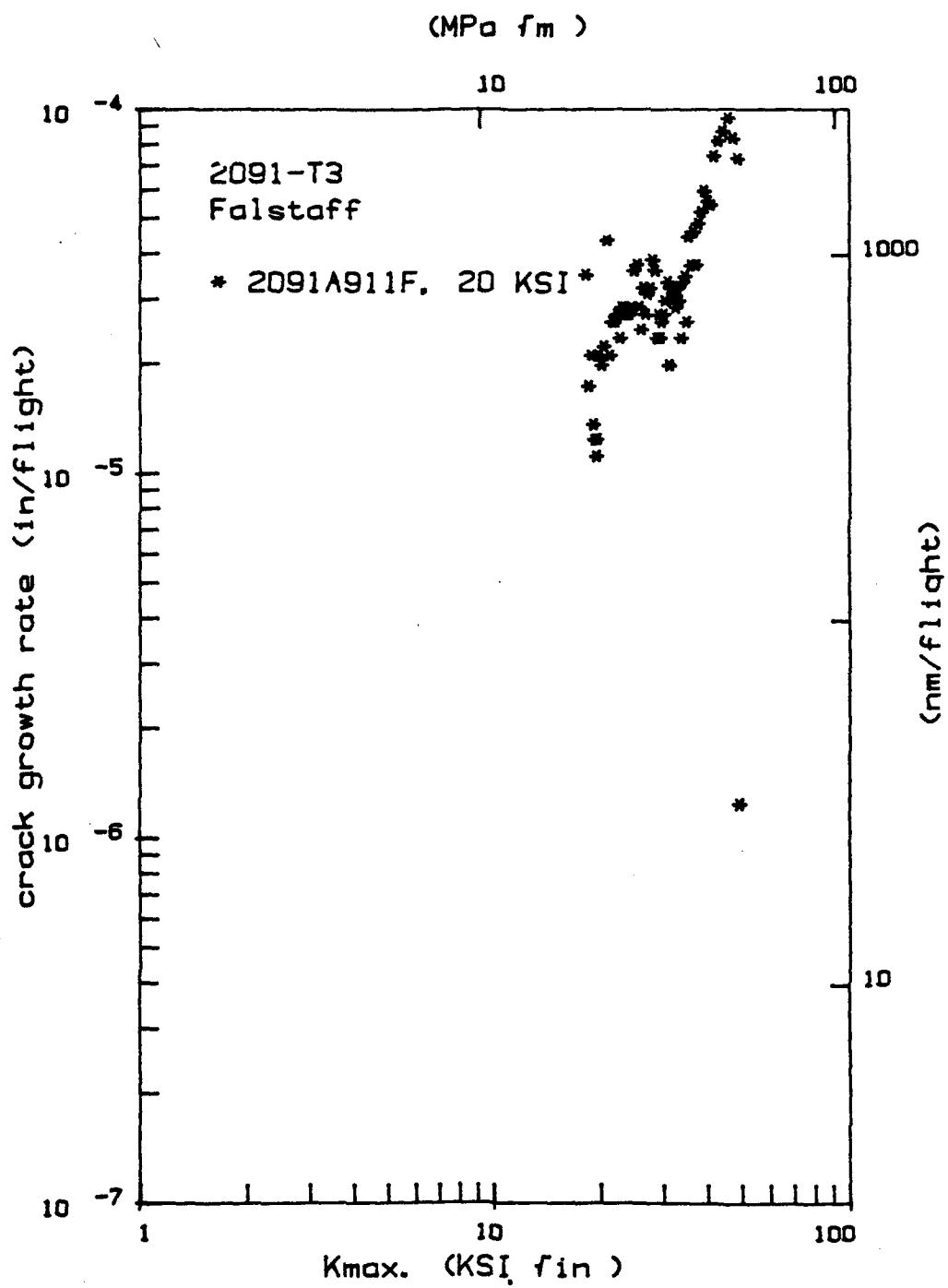


FIGURE K13. FALSTAFF SPECTRUM FATIGUE CRACK GROWTH RATE VS KMAX DATA FOR 2091-T3 0.144 INCH SHEET. AIR FORCE.

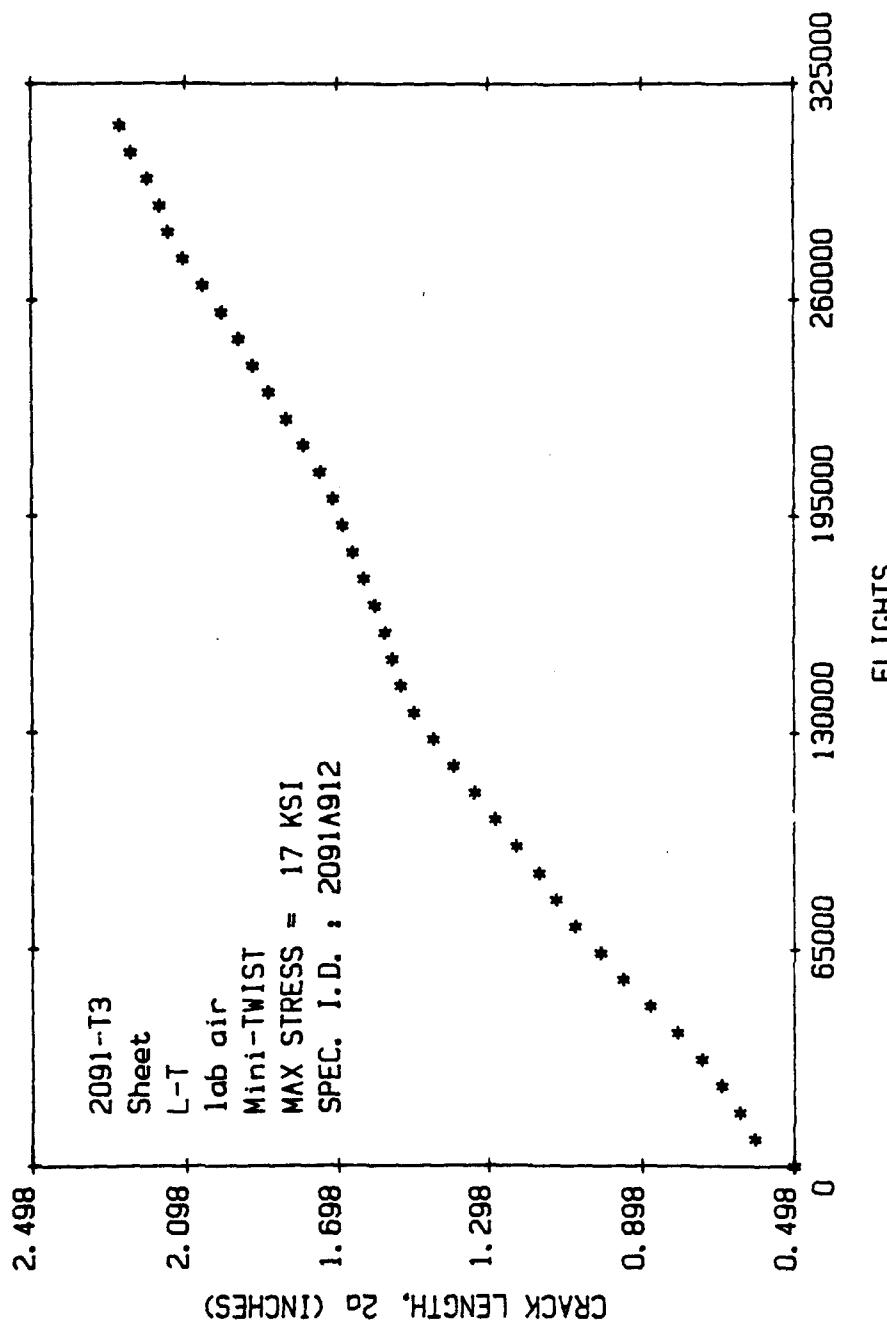


FIGURE K14. MINI-TWIST SPECTRUM FATIGUE CRACK LENGTH
 VS FLIGHTS DATA FOR 2091-T3 0.144
 INCH SHEET(SPECIMEN #2091A912)

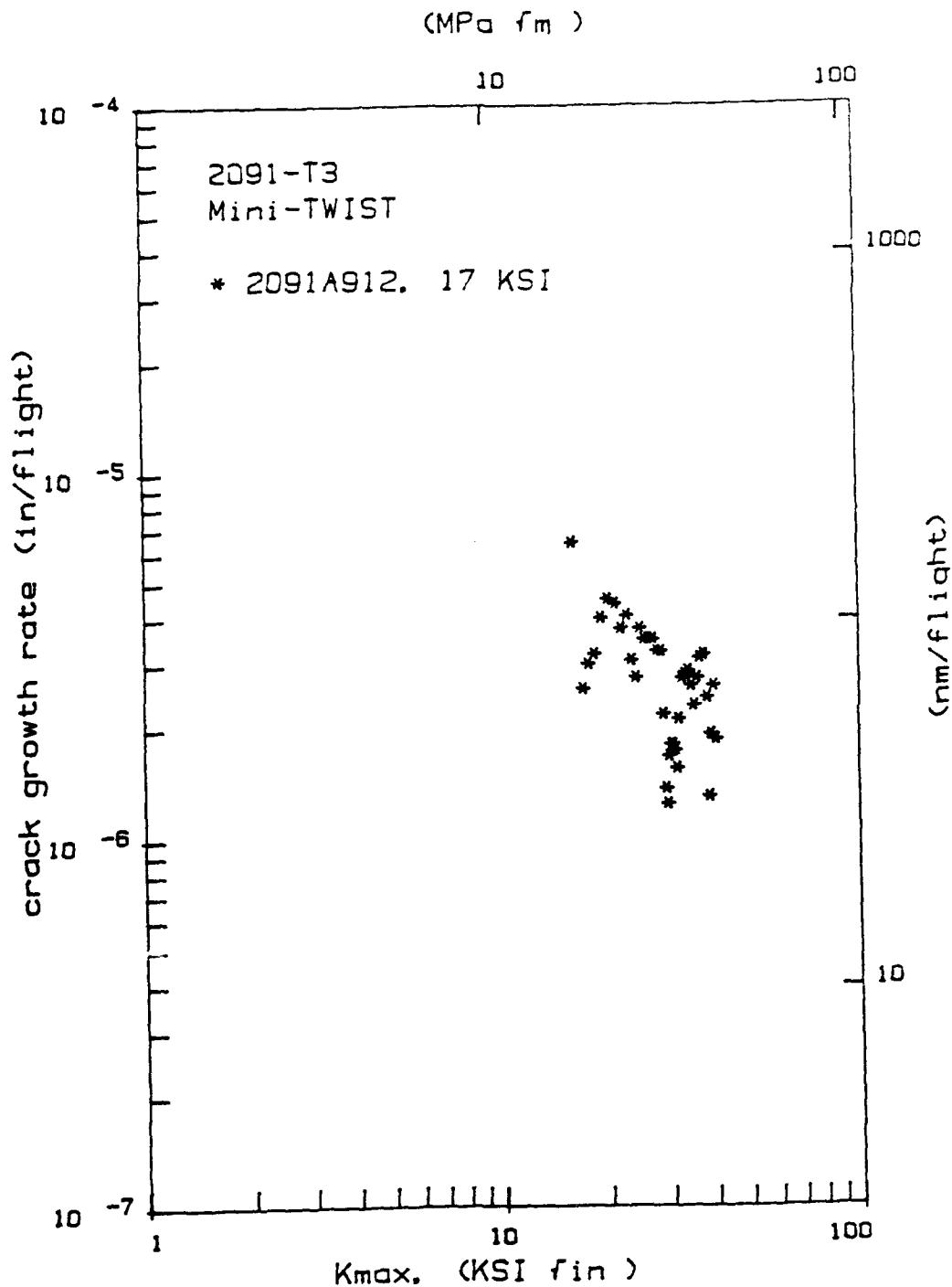


FIGURE K15. MINI-TWIST SPECTRUM CRACK GROWTH RATE
VS KMAX DATA FOR 2091-T3
0.144 INCH SHEET
(Specimen #2091A912).
AIR FORCE.

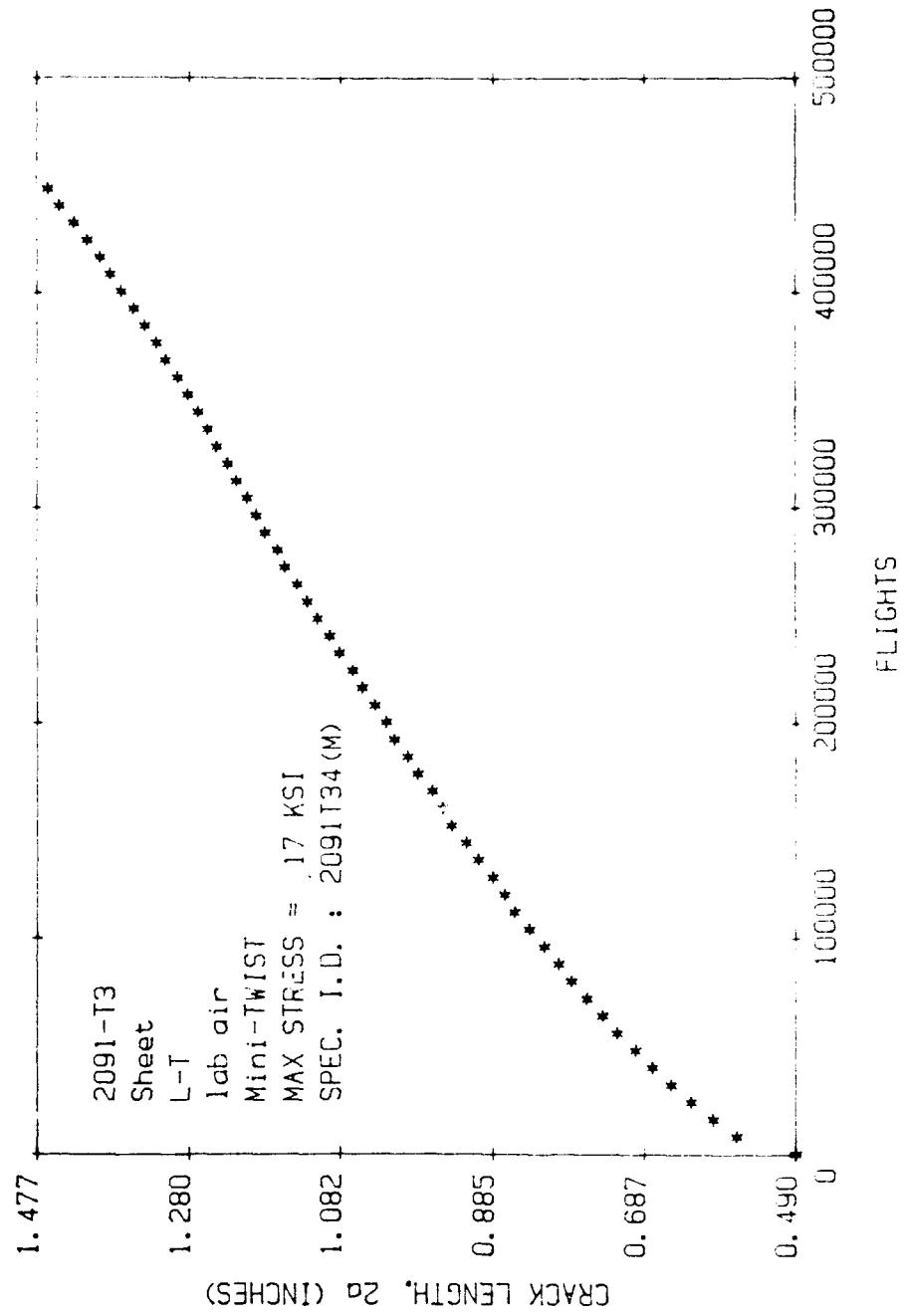


FIGURE K16 MINI-TWIST SPECTRUM FATIGUE CRACK LENGTH
 VS FLIGHTS DATA FOR 2091-T3 0144
 INCH SHEET(SPECIMEN #2091T34M).
 AIR FORCE

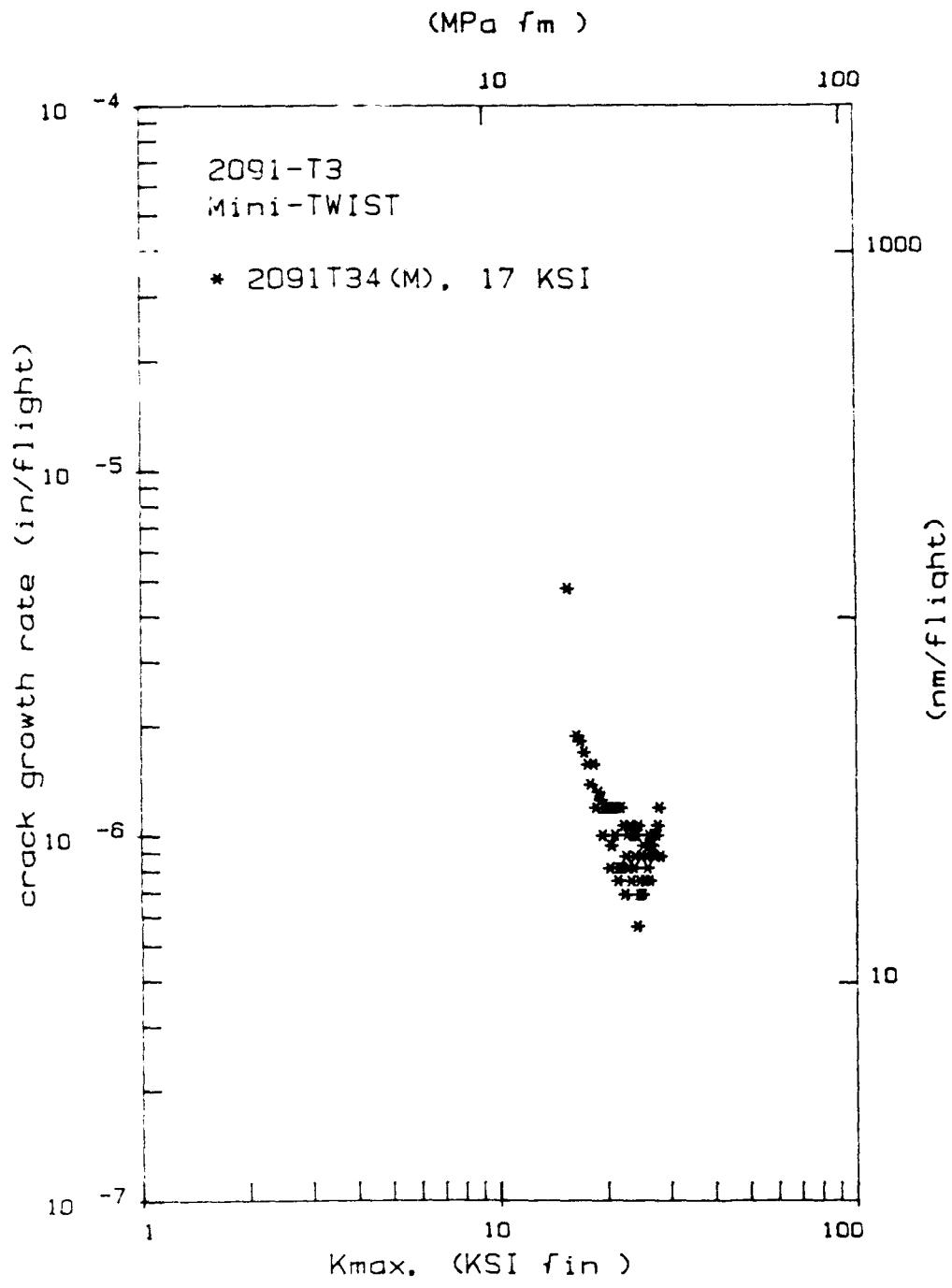


FIGURE K17. MINI-TWIST SPECTRUM CRACK GROWTH RATE VS KMAX DATA FOR 2091-T3 0.144 INCH SHEET (SPECIMEN #2091T34M). AIR FORCE.

TABLE K29
TENSILE RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")
AGED 16 HOURS AT 335 F

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
GENERAL DYNAMICS, TEXAS	RT	LONG	67.3	56.1	14.2		
			67.1	56.3	14.3		
		AVERAGE	67.2	56.2	14.3		
		STANDARD DEVIATION	0.1	0.1	0.1		

TABLE K30
TENSILE RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")
AGED 16 HOURS AT 335 F

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
GENERAL DYNAMICS, TEXAS	RT	45	65.3	46.7	19.2		
			65.6	47.4	19.8		
		AVERAGE	65.5	47.1	19.5		
		STANDARD DEVIATION	0.2	0.5	0.4		

TABLE K31
TENSILE RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")
AGED 16 HOURS AT 335 F

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
GENERAL DYNAMICS, TEXAS	RT	L TRANS	70.7 70.9	51.3 52.8	12.8 11.1		
		AVERAGE	70.8	52.1	12.0		
		STANDARD DEVIATION	0.1	1.1	1.2		

TABLE K32
TENSILE RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")
AGED 32 HOURS AT 335 F

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
GENERAL DYNAMICS, TEXAS	RT	LONG	69.6 69.9	58.8 59.4		15.3	
		AVERAGE	69.8	59.1	15.3		
		STANDARD DEVIATION	0.2	0.4			

TABLE K33
 TENSILE RESULTS FOR ALCOA
 2091-T3 SHEET (0.144" X 48" X 48")
 AGED 32 HOURS AT 335 F

COMPANY	TEST TEMP	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
	(DEGREES F)						
GENERAL DYNAMICS, TEXAS	RT	45	68.8 68.1	51.9 51.1	17.9 18.5		
		AVERAGE	68.5	51.5	18.2		
		STANDARD DEVIATION	0.5	0.6	0.4		

TABLE K34
 TENSILE RESULTS FOR ALCOA
 2091-T3 SHEET (0.144" X 48" X 48")
 AGED 32 HOURS AT 335 F

COMPANY	TEST TEMP	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
	(DEGREES F)						
GENERAL DYNAMICS, TEXAS	RT	L TRANS	73.9 74.5	57.0 54.5	15.6 14.3		
		AVERAGE	74.2	55.8	15.0		
		STANDARD DEVIATION	0.4	1.8	0.9		

TABLE K35

KAHN TEAR TEST RESULTS FOR ALCOA
 2091-T3 SHEET (0.144" X 48" X 48")
 AGED 16 HOURS AT 335 F

COMPANY	ORIENTATION	TEAR STRENGTH (KSI)
GENERAL DYNAMICS, TEXAS	L-T	81.4 78.8
	AVERAGE	80.1
	STANDARD DEVIATION	1.9

TABLE K36

KAHN TEAR TEST RESULTS FOR ALCOA
 2091-T3 SHEET (0.144" X 48" X 48")
 AGED 16 HOURS AT 335 F

COMPANY	ORIENTATION	TEAR STRENGTH (KSI)
GENERAL DYNAMICS, TEXAS	45-45	74.6
	AVERAGE	74.6
	STANDARD DEVIATION	

TABLE K37
KAHN TEAR TEST RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")
AGED 16 HOURS AT 335 F

COMPANY	ORIENTATION	TEAR STRENGTH (KSI)
GENERAL DYNAMICS, TEXAS	T-L	78.2 77.3
	AVERAGE	77.7
	STANDARD DEVIATION	0.6

TABLE K38
KAHN TEAR TEST RESULTS FOR ALCOA
2091-T3 SHEET (0.144" X 48" X 48")
AGED 32 HOURS AT 335 F

COMPANY	ORIENTATION	TEAR STRENGTH (KSI)
GENERAL DYNAMICS, TEXAS	L-T	76.4 74.6
	AVERAGE	75.5
	STANDARD DEVIATION	1.3

TABLE K39
 KAHN TEAR TEST RESULTS FOR ALCOA
 2091-T3 SHEET (0.144" X 48" X 48")
 AGED 32 HOURS AT 335 F

COMPANY	ORIENTATION	TEAR STRENGTH (KSI)
GENERAL DYNAMICS, TEXAS	45-45	73.7 74.1
	AVERAGE	73.9
	STANDARD DEVIATION	0.2

TABLE K40
 KAHN TEAR TEST RESULTS FOR ALCOA
 2091-T3 SHEET (0.144" X 48" X 48")
 AGED 32 HOURS AT 335 F

COMPANY	ORIENTATION	TEAR STRENGTH (KSI)
GENERAL DYNAMICS, TEXAS	T-L	74.7
	AVERAGE	74.7
	STANDARD DEVIATION	

TABLE 41
 TEAR-YIELD STRENGTH RATIOS FOR ALCOA
 2091-T3 SHEET (0.144" X 48" X 48")
 AGED 16 HOURS AT 335 F

COMPANY	TENSILE-TEAR ORIENTATION	TEAR-YIELD STRENGTH RATIO
GENERAL DYNAMICS, TEXAS	L/L-T	1.42
	LT/T-L	1.48
	45/45-45	1.58
	L/T-L	1.38

TABLE 42
 TEAR-YIELD STRENGTH RATIOS FOR ALCOA
 2091-T3 SHEET (0.144" X 48" X 48")
 AGED 32 HOURS AT 335 F

COMPANY	TENSILE-TEAR ORIENTATION	TEAR-YIELD STRENGTH RATIO
GENERAL DYNAMICS, TEXAS	L/L-T	1.27
	LT/T-L	1.34
	45/45-45	1.44
	L/T-L	1.26

Alcoa 2091 .144" Sheet

Aged 16/32 Hours at 335°F

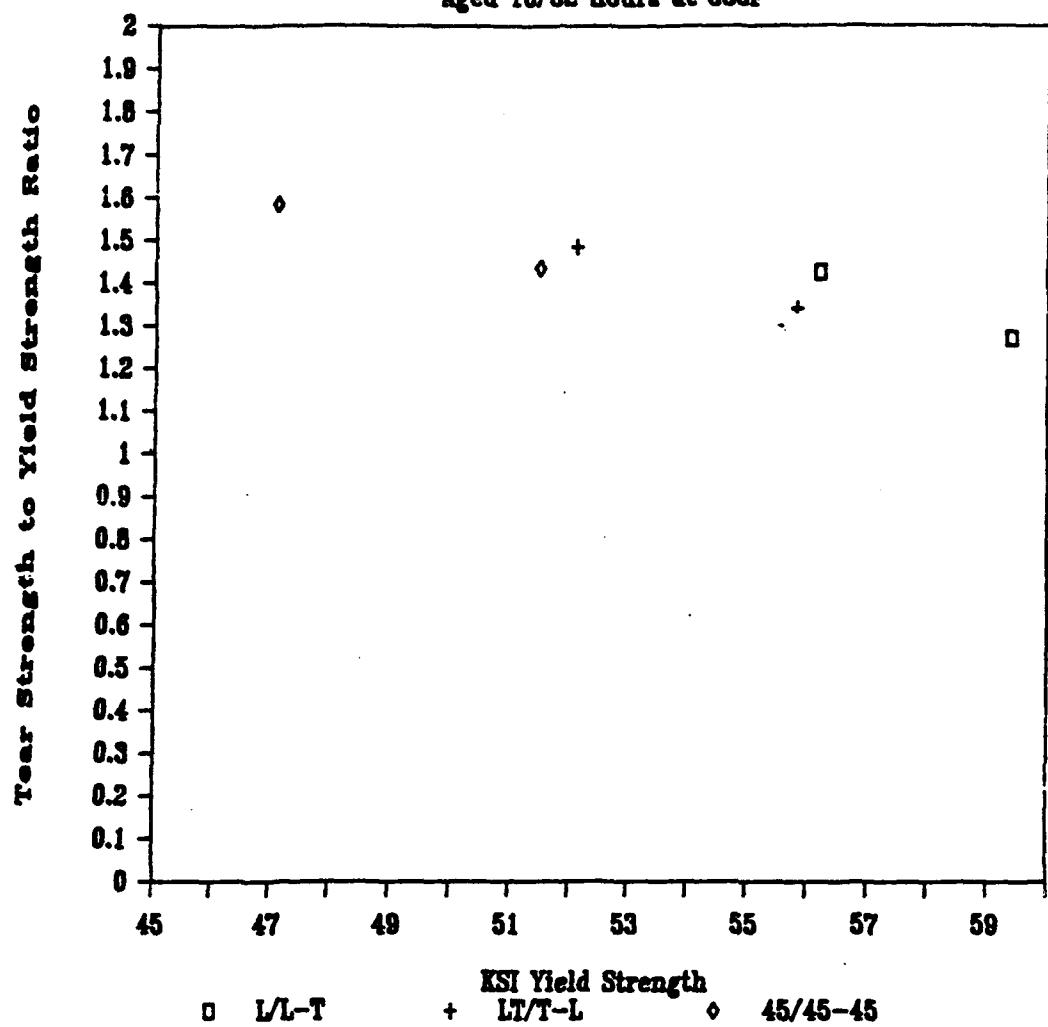


FIGURE K18. TEAR STRENGTH to YIELD STRENGTH RATIO VS YIELD STRENGTH DATA for 2091-T3 Aged 16/32 Hours at 335°F. General Dynamics.

TABLE K43
TENSILE RESULTS FOR ALCOA
2091-T8X SHEET (0.144" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
NORTHROP	RT	LONG	63.4	53.5	15.6		10.8
			63.2	53.3	16.7		10.2
			63.7	53.7	14.7		10.5
			63.2	53.6	12.6		10.8
		AVERAGE	63.4	53.5	14.9		10.6
		STANDARD DEVIATION	0.2	0.2	1.7		0.3

TABLE K44
TENSILE RESULTS FOR ALCOA
2091-T8X SHEET (0.144" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
NORTHROP	RT	45		44.3			10.4
			63.3	44.1	19.8		10.5
			62.4	43.5	17.8		11.8
			62.8	44.9	19.2		11.9
		AVERAGE	62.8	44.2	18.9		11.2
		STANDARD DEVIATION	0.5	0.6	1.0		0.8

TABLE K45
TENSILE RESULTS FOR ALCOA
2091-T8X SHEET (0.144" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
NORTHROP	RT	L TRANS	67.5	48.7	12.1		10.6
			68.2	49.2	12.7		11.2
			67.8	48.8	13.1		11.3
		AVERAGE	67.8	48.9	12.6		11.0
		STANDARD DEVIATION	0.4	0.3	0.5		0.4

TABLE K46
COMPRESSION RESULTS FOR ALCOA
2091-T8X SHEET (0.144" X 48" X 48")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)
NORTHROP	RT	LONG	42.7 42.5 42.9	12.0 11.5 11.7
		AVERAGE	42.7	11.7
		STANDARD DEVIATION	0.3	0.2

TABLE K47
COMPRESSION RESULTS FOR ALCOA
2091-T8X SHEET (0.144" X 48" X 48")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)
NORTHROP	RT	L TRANS	51.5 51.4 51.3	11.5 11.3 11.3
		AVERAGE	51.4	11.4
		STANDARD DEVIATION	0.1	0.1

TABLE K48
SLOTTED SHEAR RESULTS FOR ALCOA
2091-T8X SHEET (0.144" X 48" X 48")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
NORTHROP	LONG	40.6
		40.5
		40.5
	AVERAGE	40.5
	STANDARD DEVIATION	0.1

TABLE K49
SLOTTED SHEAR RESULTS FOR ALCOA
2091-T8X SHEET (0.144" X 48" X 48")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
NORTHROP	L TRANS	43.0
		43.0
		43.2
	AVERAGE	43.1
	STANDARD DEVIATION	0.1

TABLE K50
BEARING RESULTS FOR ALCOA
2091-T8X SHEET (0.144" X 48" X 48")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
NORTHROP	LONG	1.5	96.8 92.9	76.3 73.6
		AVERAGE	94.9	75.0
		STANDARD DEVIATION	2.8	1.9

TABLE K51
BEARING RESULTS FOR ALCOA
2091-T8X SHEET (0.063" X 48" X 48")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
NORTHROP	L TRANS	1.5	100.8 99.3 97.0	76.1 75.1 74.0
		AVERAGE	99.0	75.1
		STANDARD DEVIATION	1.9	1.1

TABLE K52

BEARING RESULTS FOR ALCOA

2091-T6X SHEET (.144" X 48" X 48")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
NORTHROP	LONG	2.0	120.7 122.4 123.9	89.8 89.1 91.8
		AVERAGE	122.3	90.2
		STANDARD DEVIATION	1.6	1.4

TABLE K53

BEARING RESULTS FOR ALCOA

2091-T8X SHEET (.144" X 48" X 48")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
NORTHROP	L TRANS	2.0	125.6 126.9 126.1	91.9 91.0 94.6
		AVERAGE	126.2	92.5
		STANDARD DEVIATION	0.7	1.9

TABLE K54

R-CURVE FRACTURE TOUGHNESS RESULTS FOR
ALCOA 2C91-T8X SHEET (0.144" X 48" X 48")

COMPANY	SPECIMEN I.D.	ORIENTATION	Kc (KSI SQRT-IN)
NORTHROP	T6RL1	L-T	135.0

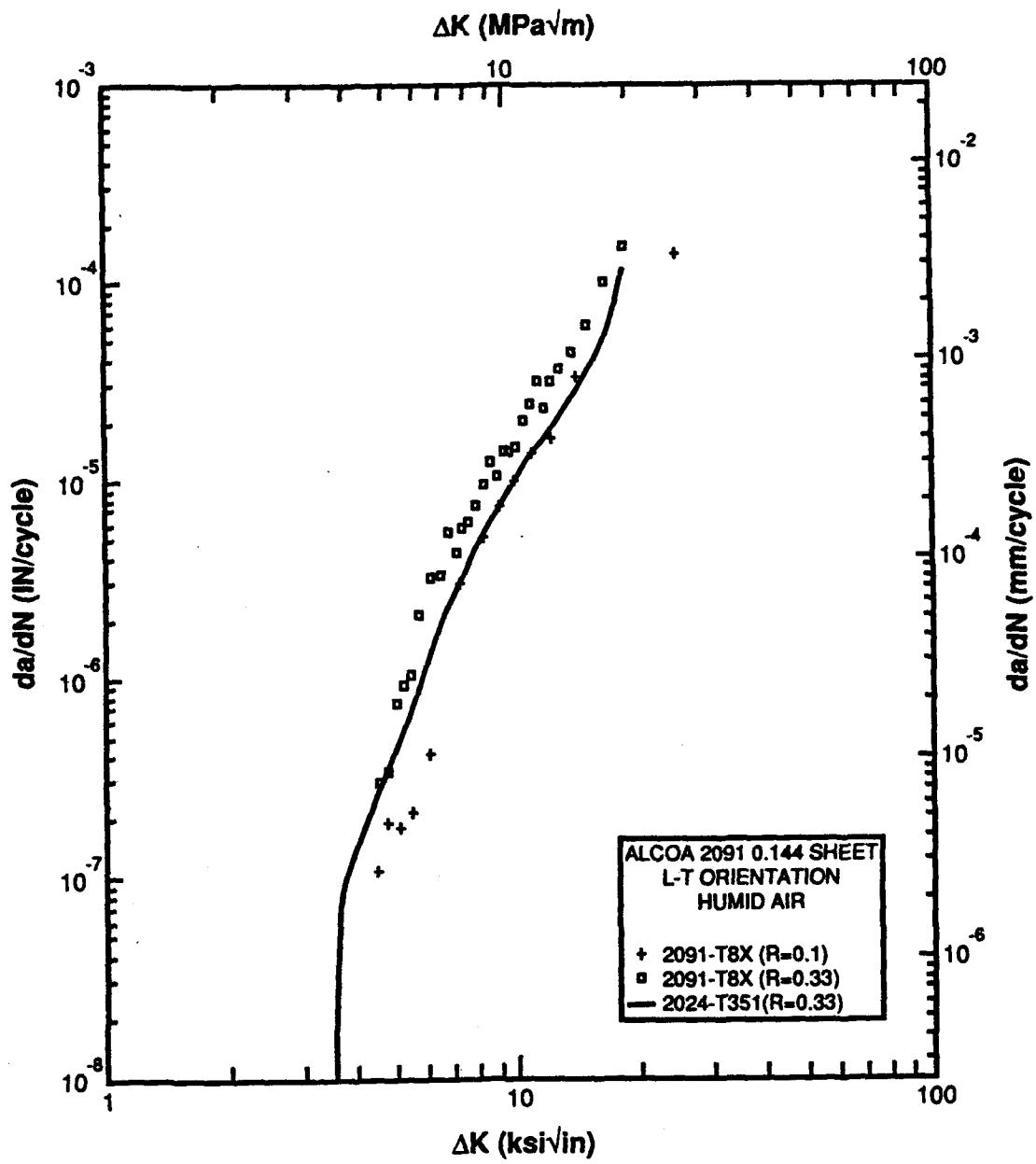


FIGURE K19. FATIGUE CRACK GROWTH RATES FOR
2091-T8X 0.144 INCH SHEET RELATIVE
TO 2024-T351 (L-T ORIENTATION).
NORTHROP.

TABLE K55
FATIGUE CRACK GROWTH RATE DATA ASSOCIATED
WITH FIGURE K19 (SPECIMEN T6 FL-1)

CRACK GROWTH TEST OF ALCOA 2091			SPEC T6FL-1	
M(T)	SPECIMEN TYPE	L-T ORIENTATION		
TEMP = 80		REL HUM = 95 %	11-MAY-89	
W = 2.9998 IN		B = .142 IN		R = .1
FREQUENCY = 10 Hz		HUMID AIR ENVIRONMENT		
GRID SPACING = .05 IN		FILE CODE: RK1:C00145.DDN		
YIELD STRESS = 54 KSI		FITO CODE: RK1:C00145.DFO		

SPECIMEN T6FL-1			M(T) SPECIMEN TYPE				
REF #	K-MAX	2A IN	2A/W	K-BAR	DELTA K-BAR	DA/DN IN/CYC	VALID PER ABTM
	4.9	.3041	.1014				
2	5.09	.3281	.1094	5	4.5	1.08794E-07	Y
3	5.48	.3781	.126	5.29	4.76	1.91278E-07	Y
4	5.88	.4326	.1442	5.68	5.11	1.81063E-07	Y
5	6.25	.4846	.1613	6.06	5.46	2.16216E-07	Y
6	7.22	.6331	.211	6.74	6.07	4.36765E-07	Y
7	8.81	.8901	.2967	8.02	7.22	3.21250E-06	Y
8	9.51	1.0046	.3349	9.16	8.25	5.45238E-06	Y
9	10.34	1.1361	.3787	9.92	8.93	7.73530E-06	Y
10	11.33	1.2871	.4291	10.83	9.75	1.04138E-05	Y
11	12.64	1.4711	.4904	11.97	10.77	1.47200E-05	Y
12	14.18	1.6631	.5544	13.39	12.05	1.74545E-05	Y
13	17.13	1.9566	.6522	15.58	14.02	3.49405E-05	Y
14	48.43	2.8206	.9403	27.14	24.43	1.45651E-04	Y

TABLE K56
FATIGUE CRACK GROWTH RATE DATA ASSOCIATED
WITH FIGURE K19 (SPECIMEN T6 FL-3)

CRACK GROWTH TEST OF ALCOA 2091 SHEET					SPEC T6FL-3				
M(T)	SPECIMEN TYPE	L-T ORIENTATION							
TEMP = 78		REL HUM = 95 %				28-JUN-89			
W = 3 IN		B = .1411 IN				R = .33			
FREQUENCY = 10 HZ		HUMID AIR ENVIRONDMENT							
GRID SPACING = .05 IN		FILE CODE: RK1:D00045.DDN							
YIELD STRESS = 53.5 KSI		FITO CODE: RK1:D00045.DFO							

SPECIMEN T6FL-3				M(T) SPECIMEN TYPE			
REF #	K-MAX	2A IN	2A/W	K-BAR	DELTA K-BAR	DA/DN IN/CYC	VALID PER ASTM
1	6.59	.5301	.1767	6.76	4.53	3.15625E-07	Y
2	6.93	.5806	.1935	7.07	4.73	3.54167E-07	Y
3	7.2	.6231	.2077	7.4	4.96	7.87500E-07	Y
4	7.6	.6861	.2287	7.76	5.2	9.79999E-07	Y
5	7.91	.7351	.245	8.05	5.39	1.10000E-06	Y
6	8.18	.7791	.2597	8.45	5.66	2.18750E-06	Y
7	8.72	.8666	.2889	9.03	6.05	3.38333E-06	Y
8	9.35	.9681	.3227	9.56	6.41	3.46500E-06	Y
9	9.78	1.0374	.3458	10.06	6.74	5.63750E-06	Y
10	10.35	1.1276	.3759	10.52	7.05	4.50000E-06	Y
11	10.7	1.1816	.3939	10.85	7.27	5.87502E-06	Y
12	11.01	1.2286	.4095	11.22	7.52	6.44999E-06	Y
13	11.44	1.2931	.431	11.71	7.84	7.70000E-06	Y
14	11.98	1.3701	.4567	12.26	8.21	9.81249E-06	Y
15	12.55	1.4486	.4829	12.84	8.6	1.26667E-05	Y
16	13.13	1.5246	.5082	13.3	8.91	1.07500E-05	Y
17	13.47	1.5676	.5225	13.71	9.18	1.45000E-05	Y

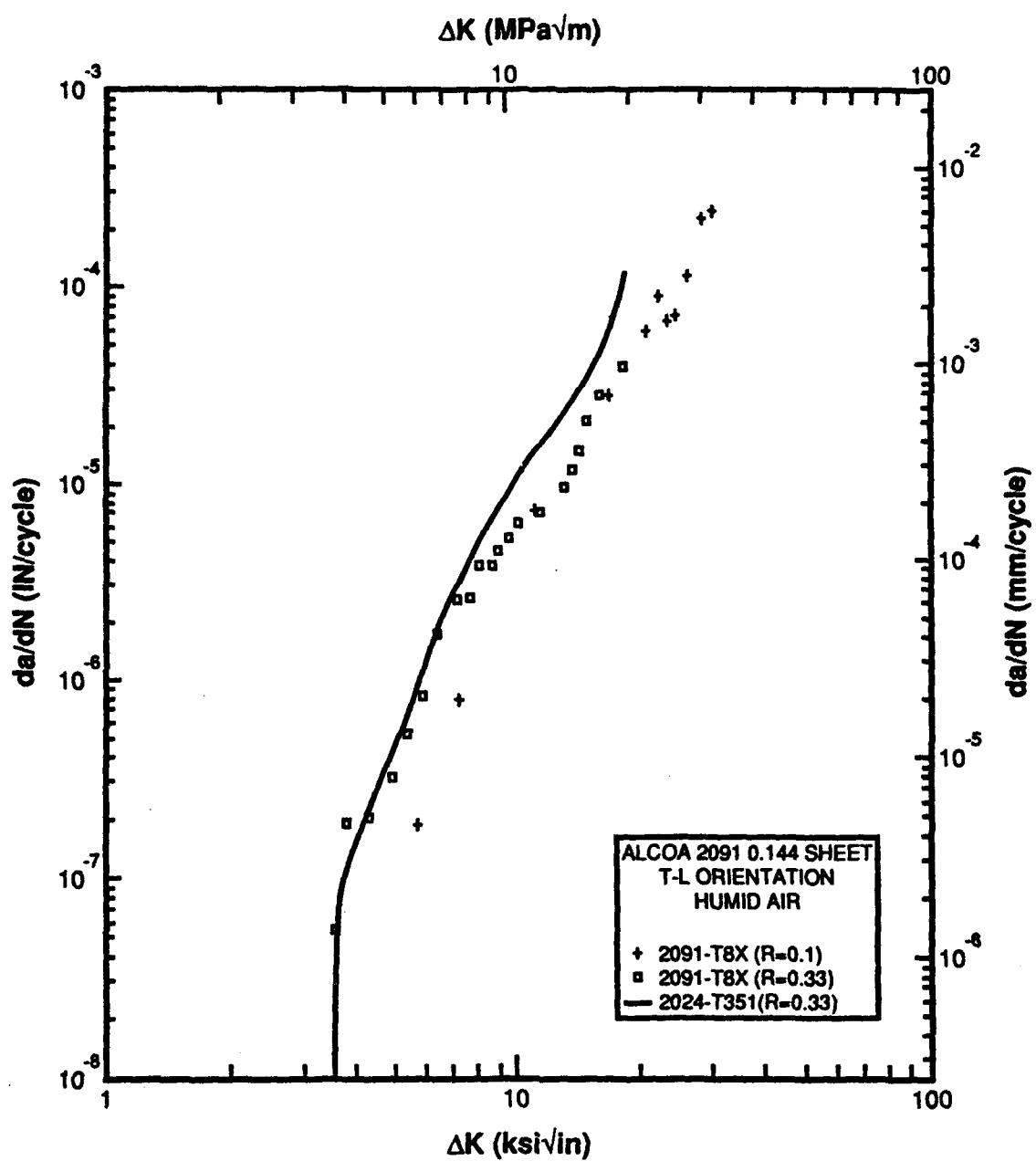


FIGURE K20. FATIGUE CRACK GROWTH RATES FOR 2091-T8X 0.144 INCH SHEET RELATIVE TO 2024-T351 (T-L ORIENTATION). NORTHROP.

TABLE K57
FATIGUE CRACK GROWTH RATE DATA ASSOCIATED
WITH FIGURE K20 (SPECIMEN T6 FL-1)

CRACK GROWTH TEST OF ALCOA 2091 SHEET			SPEC T6FT-1
M(T)	SPECIMEN TYPE	T-L ORIENTATION	
TEMP = 80		REL HUM = 95 %	12-JUL-89
W = 3 IN		B = .1424 IN	R = .1
FREQUENCY = 10 HZ	HUMID AIR ENVIRONMENT		
GRID SPACING = .05 IN	FILE CODE: RK1:D00046.DDN		
YIELD STRESS = 49 KSI	FIT0 CODE: RK1:D00047.DFO		

SPECIMEN T6FT-1			M(T) SPECIMEN TYPE				
REF	K-MAX	2A IN	2A/W	K-BAR	DELTA K-BAR	DA/DN IN/CYC	VALID PER ASTM
1	5.57	.1437	.0479	6.27	5.64	1.93750E-07	Y
2	6.92	.2212	.0737	7.89	7.1	8.28125E-07	Y
3	8.8	.3537	.1179	12.19	10.97	7.56875E-06	Y
4	15.35	.9592	.3197	18.52	16.66	2.93750E-05	Y
5	21.97	1.5467	.5156	22.81	20.53	6.17500E-05	Y
6	23.67	1.6702	.5567	24.36	21.93	9.30001E-05	Y
7	25.08	1.7632	.5877	25.63	23.07	6.84999E-05	Y
8	26.2	1.8317	.6106	26.84	24.15	7.35000E-05	Y
9	27.49	1.9052	.6351	28.62	25.76	1.17000E-04	Y
10	29.8	2.0222	.6741	30.82	27.74	2.28751E-04	Y
11	31.88	2.1137	.7046	32.7	29.43	2.51922E-04	Y
12	33.55	2.1792	.7264				

TABLE K58
FATIGUE CRACK GROWTH RATE DATA ASSOCIATED
WITH FIGURE K20 (SPECIMEN T6FT-3)

CRACK GROWTH TEST OF ALCDA 2091					SPEC T6FT-3		
M(T)	SPECIMEN TYPE	T-L ORIENTATION					
TEMP = 80		REL HUM =	50 %	08-06-89			
W = 3.0002 IN		B =	.1425 IN	R = .33			
FREQUENCY = 10	HZ	LAB AIR ENVIRONMENT					
GRID SPACING =	.05 IN	FILE CODE: RK1:A00702.DDN					
YIELD STRESS =	54 KSI	FITO CODE: RK1:A00702.DFO					
SPECIMEN T6FT-3		M(T) SPECIMEN TYPE					
REF	K-MAX	2A IN	2A/W	K-BAR	DELTA K-BAR	DA/DN IN/CYC	VALID PER ASTM
1	5.31	.2652	.0884	5.38	3.6	5.72917E-08	Y
2	5.45	.279	.093	5.68	3.8	1.93582E-07	Y
3	5.9	.3257	.1086	6.46	4.33	2.06557E-07	Y
4	6.99	.4517	.1506	7.29	4.88	3.29422E-07	Y
5	7.58	.5247	.1749	7.98	5.34	5.51316E-07	Y
6	8.37	.6294	.2098	8.67	5.81	8.59134E-07	Y
7	8.98	.7127	.2376	9.42	6.31	1.77857E-06	Y
8	9.87	.8372	.279	10.54	7.06	2.69286E-06	Y
9	11.21	1.0257	.3419	11.41	7.64	2.70000E-06	Y
10	11.6	1.0797	.3599	12.11	8.11	3.98551E-06	Y
11	12.63	1.2172	.4057	12.86	8.61	4.05405E-06	Y
12	13.09	1.2772	.4257	13.36	8.95	4.72222E-06	Y
13	13.63	1.3452	.4484	14.19	9.51	5.44355E-06	Y
14	14.77	1.4802	.4934	15.06	10.09	6.55000E-06	Y
15	15.36	1.5457	.5152	17.12	11.47	7.40938E-06	Y
16	19.08	1.8932	.631	19.51	13.07	1.01515E-05	Y
17	19.96	1.9602	.6534	20.22	13.55	1.24167E-05	Y
18	20.48	1.9975	.6658	21.05	14.1	1.52499E-05	Y
19	21.64	2.0737	.6912	22.17	14.85	2.14167E-05	Y
20	22.71	2.1379	.7126	23.53	15.76	2.94166E-05	Y
21	24.38	2.2262	.742	26.72	17.9	4.02000E-05	Y
22	29.4	2.4272	.809				

APPENDIX L
2091-T8 0.5 Inch Plate

TABLE L1
TENSILE RESULTS FOR ALCOA
2091-T8 PLATE (0.5" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)		
MARTIN MARIETTA, LOUISIANA	RT	LONG	74.8	62.1	11.0	11.4			
			74.2	61.4	11.0	10.8			
			75.2	62.3	10.0	11.4			
AIR FORCE	RT	LONG	76.2	64.0	8.9	16.2			
			75.6	63.4	9.4	17.0			
			75.3	62.8	8.6	15.1			
AVERAGE			75.2	62.7	9.8	13.7			
STANDARD DEVIATION			0.7	0.9	0.4	1.1			

TABLE L2
TENSILE RESULTS FOR ALCOA
2091-T8 PLATE (0.5" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
AIR FORCE	RT	30	71.6	52.9	11.6	16.2	
			71.6	53.2	11.7	18.4	
		AVERAGE	71.6	53.1	11.7	17.3	
			0.0	0.2	0.1	1.5	

TABLE L3
TENSILE RESULTS FOR ALCOA
2091-T8 PLATE (0.5" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
AIR FORCE	RT	45	64.0	46.6	19.4	32.9	
			63.6	45.9	19.1	35.5	
			63.6	45.9	19.6	33.6	
		AVERAGE	63.7	46.1	19.4	34.0	
		STANDARD DEVIATION	0.2	0.4	0.3	1.3	

TABLE L4
TENSILE RESULTS FOR ALCOA
2091-T8 PLATE (0.5" X 48" X 48")

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
MARTIN	RT	L TRANS	72.9	55.0	14.0	18.8	
MARIETTA, LOUISIANA			72.2	54.1	14.0	18.8	
			73.5	55.0	14.0	14.2	
AIR FORCE	RT	L TRANS	73.6	55.6	12.1	24.9	
			73.8	55.7	11.5	24.5	
			73.8	55.4	13.0	22.7	
		AVERAGE	73.3	55.1	13.1	20.7	
		STANDARD DEVIATION	0.6	0.6	1.1	4.1	

TABLE L5
COMPRESSION RESULTS FOR ALCOA
2091-T8 PLATE (0.5" X 48" X 48")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (MSI)
MARTIN MARIETTA, LOUISIANA	RT	LONG	52.2	11.8
			51.4	11.8
			52.4	11.8
		AVERAGE	52.0	11.8
		STANDARD DEVIATION	0.5	0.0

TABLE L6
COMPRESSION RESULTS FOR ALCOA
2091-T8 PLATE (0.5" X 48" X 48")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)
MARTIN MARIETTA, LOUISIANA	RT	L TRANS	57.9	11.9
			58.8	11.9
		AVERAGE	58.4	11.9
		STANDARD DEVIATION	0.6	0.0

TABLE L7
FRACTURE TOUGHNESS RESULTS FOR ALCOA
2091-T8 PLATE (0.5" X 48" X 48")

COMPANY	ORIENTATION	KIC (KSI in ^{0.5})	Kq (KSI in ^{0.5})	COMMENT
MARTIN	L - T		33.8	INVALID(1)
MARIETTA, LOUISIANA			31.1	INVALID(1)
			37.4	INVALID(1)
	AVERAGE		34.1	
	STANDARD DEVIATION		3.2	

(1): SPECIMEN SIZE TOO SMALL

TABLE L8
FRACTURE TOUGHNESS RESULTS FOR ALCOA
2091-T8 PLATE (0.5" X 48" X 48")

COMPANY	ORIENTATION	KIC (KSI in ^{0.5})	Kq (KSI in ^{0.5})	COMMENT
MARTIN	T - L		34.0	INVALID(1)
MARIETTA, LOUISIANA			37.8	INVALID(1)
			37.4	INVALID(1)
	AVERAGE		36.4	
	STANDARD DEVIATION		2.1	

(1): SPECIMEN SIZE TOO SMALL

TABLE L9
POST-OVERLOAD FATIGUE TEST RESULTS for 2091-T8
0.5 INCH PLATE and 2091-T83 0.144 INCH PLATE

R=0.05 LAB AIR $\Delta K = 6.0 \text{ ksi(in)}^{0.5}$ ONE OVERLOAD CYCLE APPLIED

<u>% O.L.</u>	<u>a/W</u>	<u>Pcl/Pmax</u>	<u>da/dN @ O.L. (in/in/cyc)</u>	<u>DELAY CYCLES (x10⁻³)</u>
PLATE SPECIMEN THICKNESS = 0.250"				
80	0.369	0.402	0.184	171.7
80	0.463	0.456	0.199	146.7
80	0.559	0.449	0.414	93.4
80	0.600	0.386	0.399	85.8
PLATE SPECIMEN THICKNESS = 0.140"				
80	0.401	0.645	0.097	arrest
80	0.447	0.603	0.095	arrest
60	0.407	0.535	0.135	137.6
60	0.415	0.640	0.076	arrest
60	0.484	0.584	0.057	891.0
60	0.502	0.647	0.149	126.7
60	0.541	0.600	0.140	72.8
60	0.654	0.523	0.120	59.0
60	0.696	0.574	0.107	71.5
SHEET SPECIMEN THICKNESS = 0.140"				
60	0.264	0.516	1.227	13.2
60	0.276	0.511	0.696	31.6
60	0.314	0.505	2.435	17.4
60	0.315	0.501	1.361	19.7
60	0.349	0.483	1.133	30.3
60	0.368	0.45	2.495	13.8
60	0.400	0.413	2.331	22.0
60	0.447	0.446	1.624	14.3
60	0.516	0.379	3.143	11.6
60	0.574	0.344	3.527	10.3

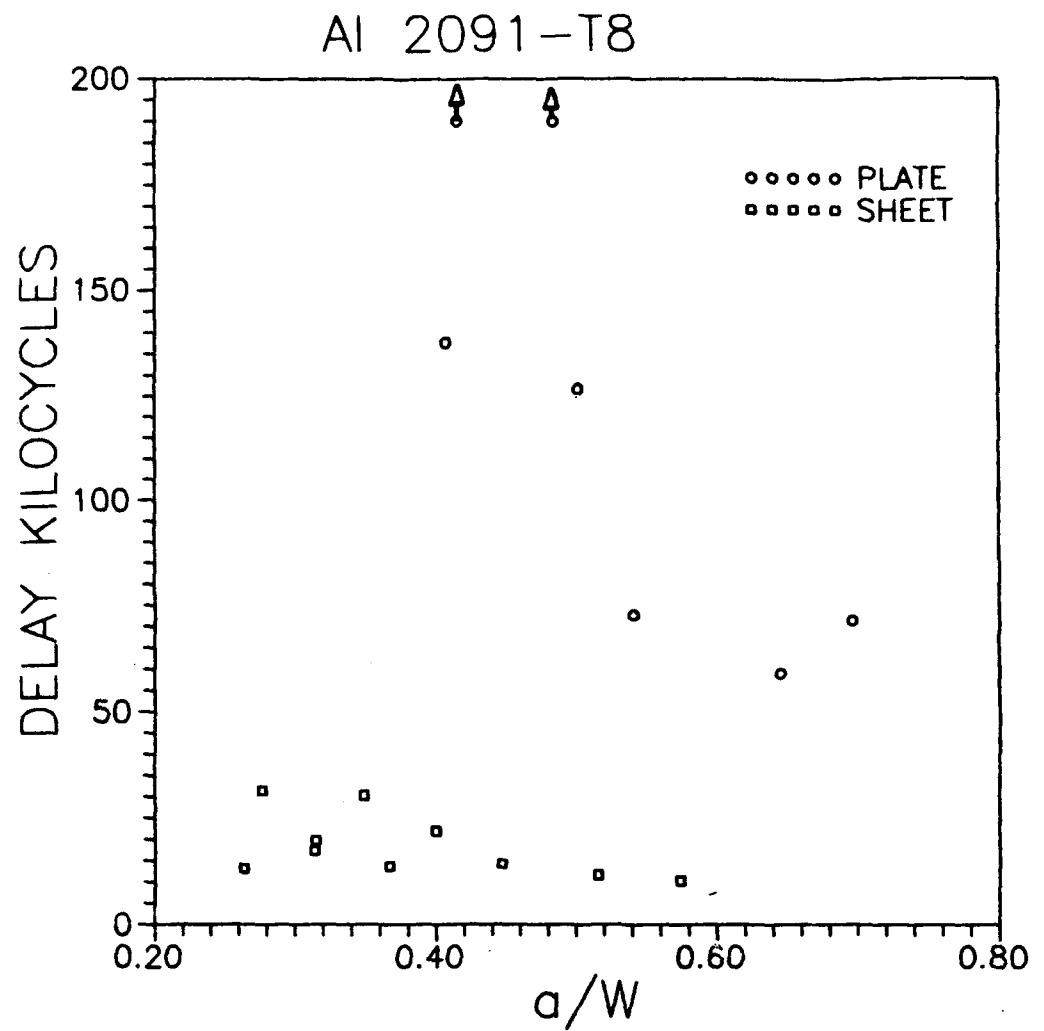


FIGURE L1. A Comparison of Delay Cycles Due to Fatigue Crack Growth Retardation for a 60 Percent Overload Cycle at a stress Intensity of 6 KSI $\sqrt{\text{in}}$ in 2091-T81 Plate Versus 2091-T83 Sheet. Thickness of the Compact Tension Specimens Used for Plate and Sheet was 0.144 Inch.

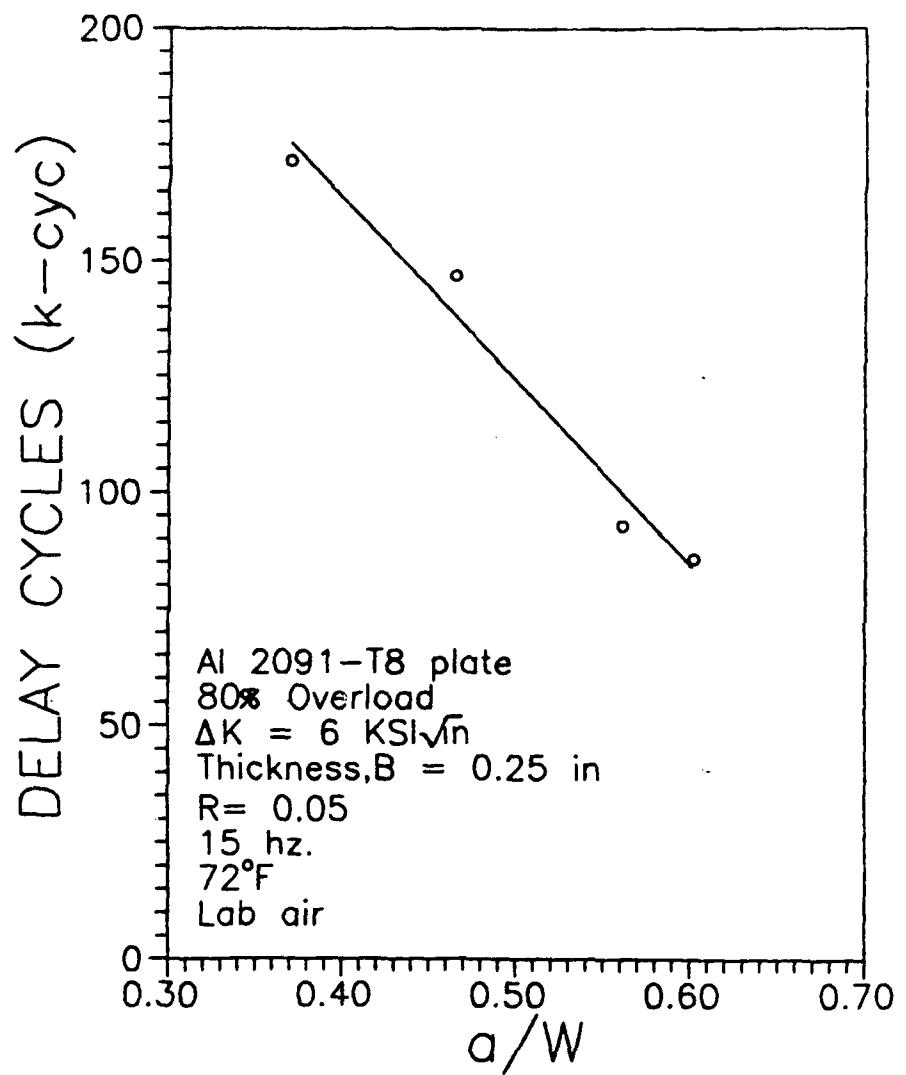


FIGURE L2. Delay Cycles Due to Fatigue Crack Growth
 Retardation for an 80 Percent Overload Cycle at
 a Stress Intensity Range of $6 \text{ KSI}\sqrt{\text{in}}$, in 2091-T81
 Plate, with a Specimen Thickness of 0.250 Inch.

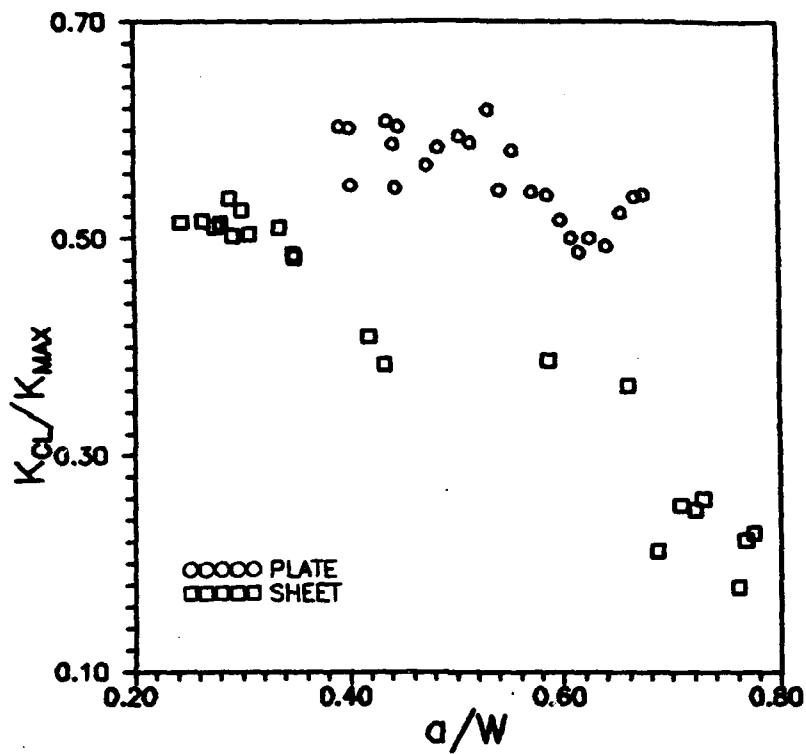


FIGURE L3. A Comparison of the Crack Closure Level Prior to the Application of a 60 Percent Overload Cycle. Note the Larger Level of Crack Closure in the Plate as Compared to Sheet Which Correlates with the Overload Delay Cycles.

TABLE L10
POST-OVERLOAD RECOVERY EXTENSION
IN 2091 PLATE AND SHEET

$\delta/K = 6.0 \text{ ksi}/(\text{in})^{.5}$
15 Hz. Lab Air

R=.05

One Overload Cycle Applied
Crack Tip Plastic Zone=0.004 (in)

<u>a/W</u>	<u>da/dN @ O.L. (in/in/cyc)</u>	<u>Accelerate Into Plastic Zone?</u>	<u>Post O.L. Recovery $\delta-A$ (in)</u>
PLATE (.250 in. thick) 80 PERCENT OVERLOAD			
0.369	0.184	Yes	0.020
0.463	0.199	Yes	0.025
0.559	0.414	Yes	0.025
0.600	0.399	Yes	0.015
PLATE (.144 in. thick) 80 PERCENT OVERLOAD			
0.401	0.097	Yes	arrest
0.447	0.095	No	arrest
PLATE (.144 in. thick) 60 PERCENT OVERLOAD			
0.407	0.135	No	0.015
0.415	0.078	No	arrest
0.484	0.057	No	0.024
0.502	0.149	No	0.016
0.541	0.140	No	0.015
0.654	0.120	No	0.009
0.696	0.107	Yes	0.016
SHEET (.144 in. thick) 60 PERCENT OVERLOAD			
0.246	1.227	Yes	0.016
0.276	0.696	Yes	0.015
0.314	2.435	Yes	0.042
0.315	1.381	Yes	0.020
0.349	1.133	No	0.020
0.368	2.495	Yes	0.026
0.400	3.331	Yes	0.025
0.447	1.624	Yes	0.016
0.516	3.143	No	0.020
0.574	3.527	Yes	0.026

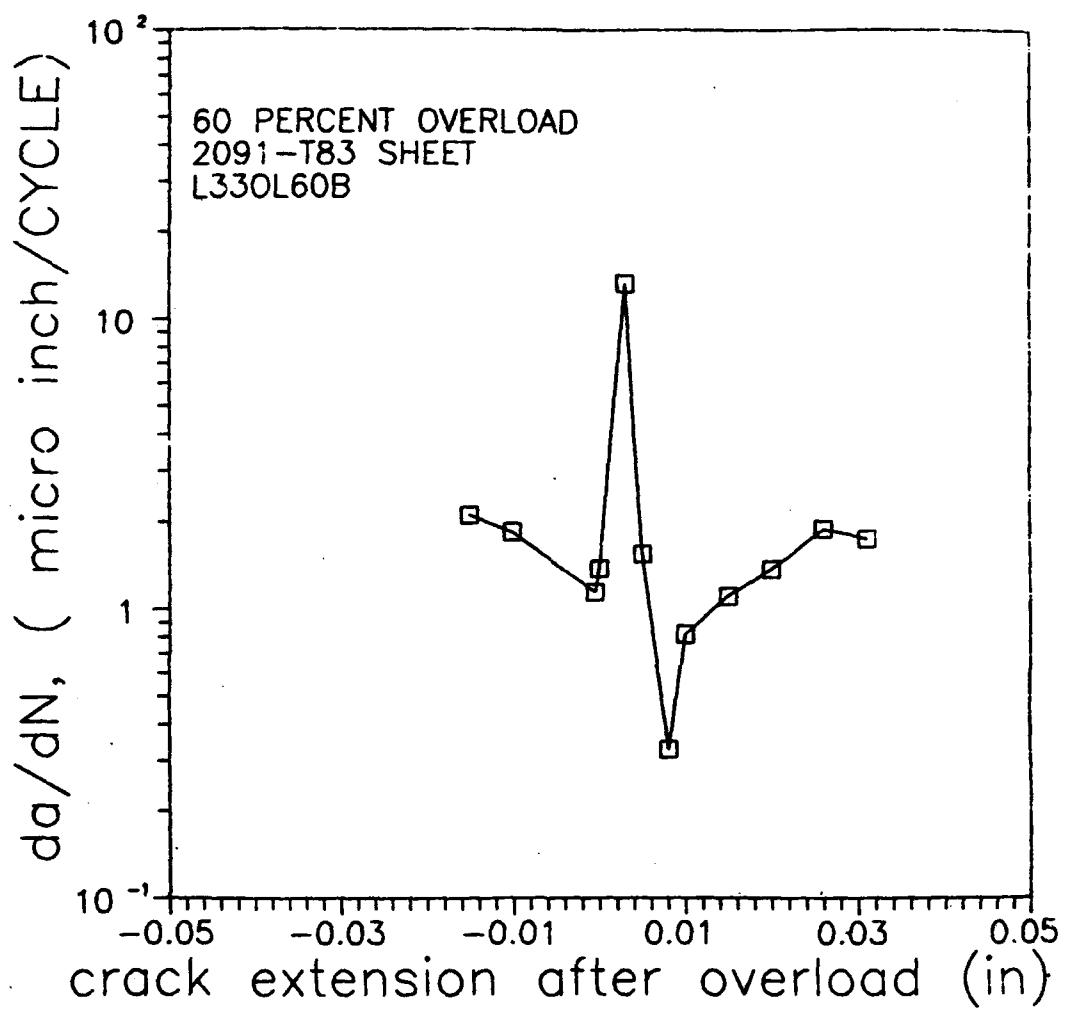


FIGURE L4. Crack Velocity Versus Post-Overload Crack Extension for Alloy 2091-T83 Sheet.

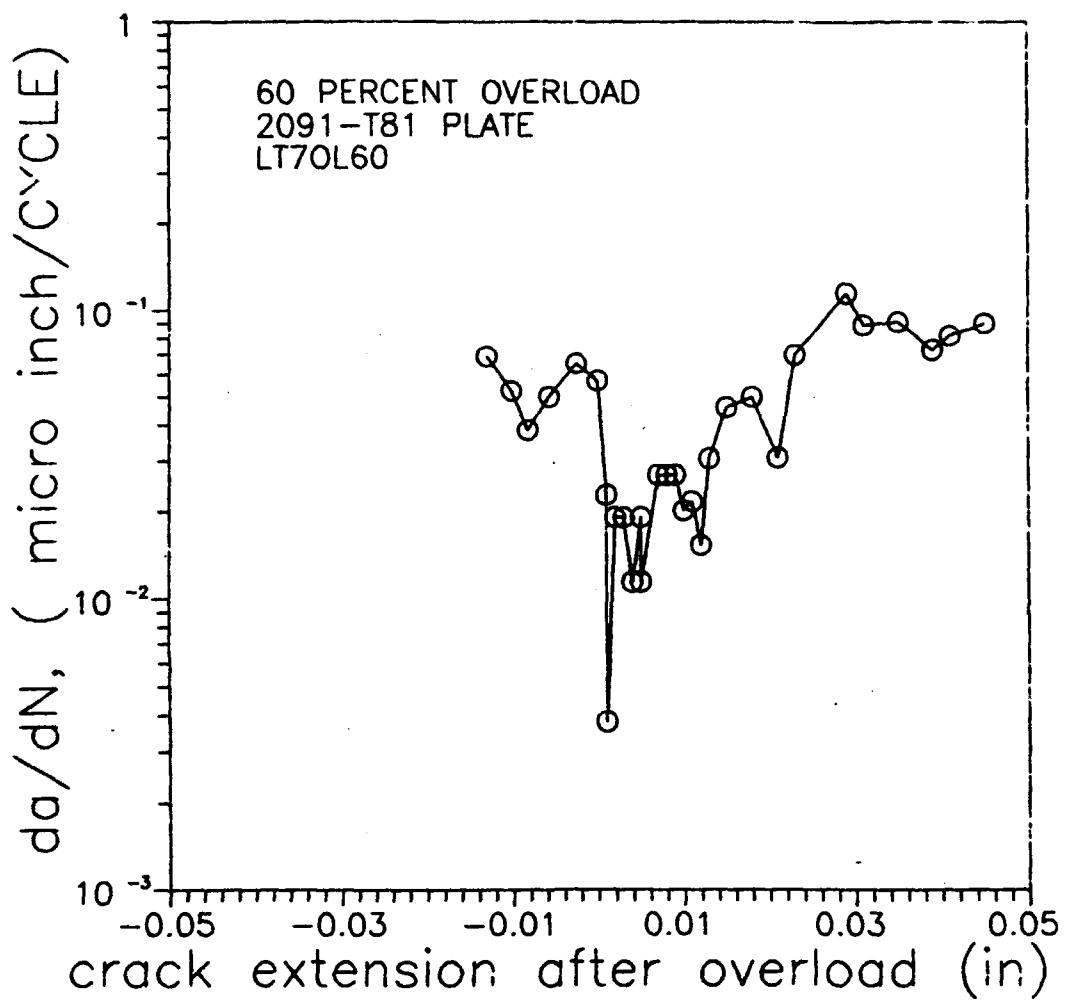


FIGURE L5. Crack Velocity Versus Post-Overload Crack Extension for Alloy 2091-T81 Plate 0.144 Inch Thick Specimen.

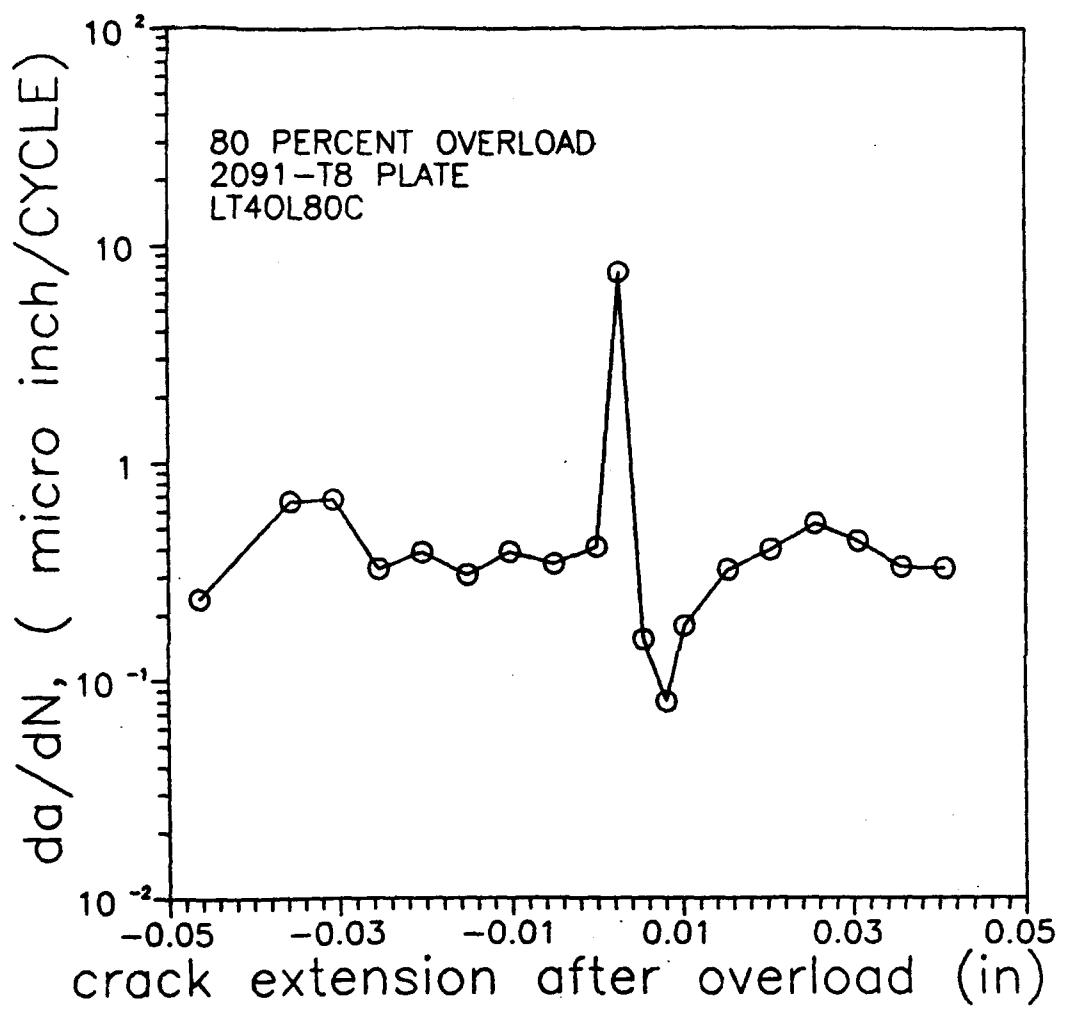
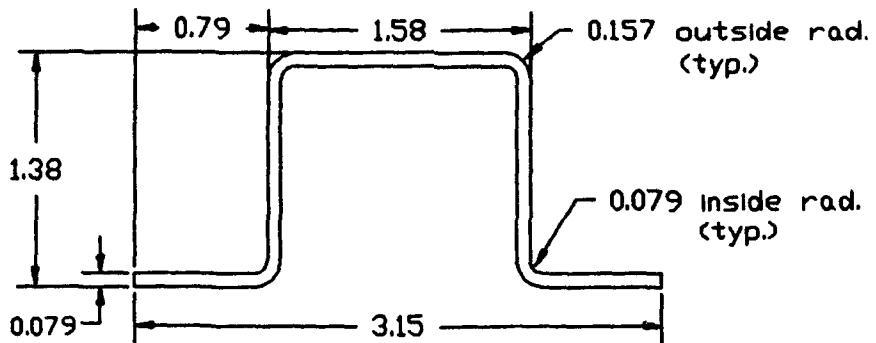


FIGURE L6. Crack Velocity Versus Post-Overload Crack Extension for Alloy 2091-T81 Plate 0.250 Inch Thick Specimen.

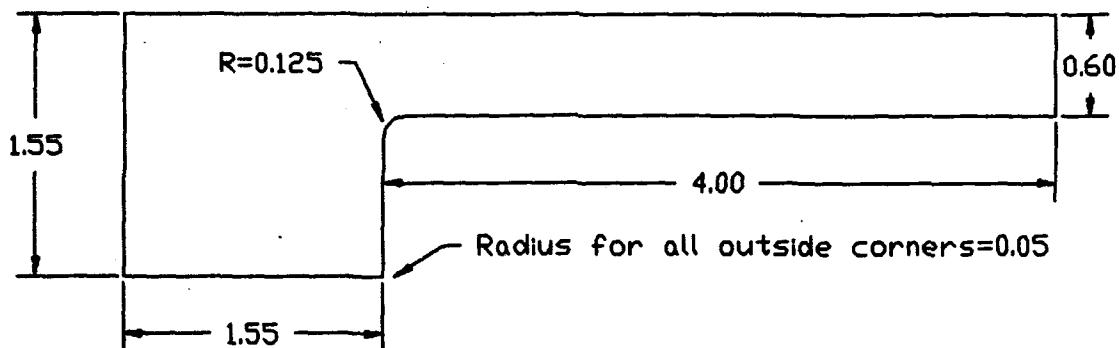
APPENDIX M

8090-T8 Hat Extrusion and 8090-T8771 L-Extrusion



ALL DIMENSIONS ARE IN INCHES

FIGURE M1. 8090-T8 HAT EXTRUSION GEOMETRY.



ALL DIMENSIONS ARE IN INCHES

FIGURE M2. 8090-T8 L-EXTRUSION GEOMETRY.

TABLE M1
TENSILE RESULTS AT $t/2$ LOCATION FOR
ALCOA 8090-T8 HAT EXTRUSION

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	COMMENT
ARMY-MTL	RT	LONG	62.5	55.4	4.1	3.9	TOP
			62.8	56.0	5.5	5.7	TOP
			63.3	55.6	5.1	5.5	TOP
			63.5	56.7	4.3	5.9	TOP
			62.8	55.9	4.7	5.3	TOP
			62.9	56.3	3.8	4.5	TOP
		AVERAGE	62.9	56.0	4.6	5.1	
		STANDARD DEVIATION	0.4	0.4	0.6	0.8	

TABLE M2
TENSILE RESULTS AT $t/2$ LOCATION FOR
ALCOA 8090-T8 HAT EXTRUSION

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	COMMENT
ARMY-MTL	RT	LONG	64.1	56.6	4.5	4.1	BOTTOM
			63.4	57.1	3.3	3.6	BOTTOM
			64.3	54.7	5.0	5.3	BOTTOM
			63.5	56.3	5.7	5.9	BOTTOM
			63.1	55.9	3.5	4.2	BOTTOM
			61.9	55.4	4.2	6.5	BOTTOM
		AVERAGE	63.4	56.0	4.4	4.9	
		STANDARD DEVIATION	0.9	0.9	0.9	1.1	

TABLE M3
 TENSILE RESULTS AT $t/2$ LOCATION FOR
 ALCOA 8090-T8 HAT EXTRUSION

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	COMMENT
ARMY-MTL	RT	LONG	64.0	55.7	5.6	5.8	SIDE
			64.3	56.9	4.1	4.2	SIDE
			64.1	57.0	4.8	5.7	SIDE
			64.7	57.4	4.5	4.1	SIDE
			65.2	57.8	5.5	3.7	SIDE
			64.5	57.3	5.5	4.6	SIDE
		AVERAGE	64.5	57.0	5.0	4.7	
		STANDARD DEVIATION	0.4	0.7	0.6	0.9	

TABLE M4
BEARING RESULTS FOR ALCOA
8090-T8 HAT EXTRUSION

COMPANY	ORIENTATION	e/D	BEARING		BEARING COMMENT
			ULT.	STR. (KSI)	
ARMY-MTL	LONG	1.5	85.9	74.2	TOP
			87.5	73.4	TOP
			85.6	75.2	TOP
	AVERAGE		86.3	74.3	
	STANDARD DEVIATION		1.0	0.9	

TABLE M5
BEARING RESULTS FOR ALCOA
8090-T8 HAT EXTRUSION

COMPANY	ORIENTATION	e/D	BEARING		BEARING COMMENT
			ULT.	STR. (KSI)	
ARMY-MTL	LONG	1.5	91.7	81.6	SIDE
			95.4	80.9	SIDE
			93.2	80.1	SIDE
	AVERAGE		93.4	80.9	
	STANDARD DEVIATION		1.9	0.7	

TABLE M6
BEARING RESULTS FOR ALCOA
8090-T8 HAT EXTRUSION

COMPANY	ORIENTATION	e/D	BEARING		BEARING COMMENT	
			ULT.	STR. (KSI)	YIELD STR. (KSI)	
ARMY-MTL	LONG	2.0	98.9		78.6	TOP
			104.0		82.5	TOP
			106.2		81.5	TOP
			AVERAGE	103.0	80.9	
			STANDARD DEVIATION	3.7	2.0	

TABLE M7
BEARING RESULTS FOR ALCOA
8090-T8 HAT EXTRUSION

COMPANY	ORIENTATION	e/D	BEARING		BEARING COMMENT	
			ULT.	STR. (KSI)	YIELD STR. (KSI)	
ARMY-MTL	LONG	2.0	116.3		89.0	SIDE
			111.6		89.0	SIDE
			112.9		89.9	SIDE
			AVERAGE	113.6	89.3	
			STANDARD DEVIATION	2.4	0.5	

TABLE M8

TENSILE RESULTS AT $t/2$ LOCATION FOR
ALCOA 8090-T8771 "L" EXTRUSION

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)		
ARMY-MTL	RT	LONG	76.0	69.6	2.8		10.9		
			68.8	57.5	3.2		11.0		
			70.8	58.0	4.7		11.3		
			69.8	58.0	5.2		11.1		
			69.4	59.0	3.4		10.8		
			69.4	58.0	4.1		11.3		
MARTIN MARIETTA, LA	RT	LONG	72.1	64.9	5.0	4.9	(1)		
			70.3	60.1	6.0	6.3	(1)		
			70.4	59.6	5.0	3.3	(1)		
			79.5	76.8	5.0	4.1	(2)		
			79.5	76.3	3.0	3.9	(2)		
			78.9	76.8	5.0	4.1	(2)		
AVERAGE			73.0	64.8	4.6	4.4	11.1		
STANDARD DEVIATION			4.4	8.4	0.9	1.0	0.2		

(1): THICK SECTION

(2): THIN SECTION

TABLE M9

TENSILE RESULTS AT $t/2$ LOCATION FOR
ALCOA 8090-T8771 "L" EXTRUSION

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)		
ARMY-MTL	RT	L TRANS	68.2	52.8	6.3		11.0		
			68.4	53.8	5.0		10.8		
			68.6	53.0	6.5		10.6		
			68.0	52.5	6.5		10.3		
			67.5	54.0	4.1		11.0		
			68.5	53.5	5.9		10.8		
MARTIN MARIETTA, LA	RT	L TRANS	69.9	55.1	8.0	11.0	(1)		
			69.6	55.4	7.0	8.0	(1)		
			70.0	55.2	8.5	9.0	(1)		
AVERAGE			68.7	53.9	6.4	9.3	10.8		
STANDARD DEVIATION			0.9	1.1	1.4	1.5	0.3		

(1): THIN SECTION

TABLE M10
TENSILE RESULTS AT $t/2$ LOCATION FOR
ALCOA 8090-T8771 "L" EXTRUSION

COMPANY	TEST TEMP (DEGREES F)	ORIENT- ATION (S)	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
ARMY-MTL	RT	S TRANS	66.5 58.3 67.0	51.0 43.0 52.0	6.0 8.0 8.0		9.9 9.6 9.8
		AVERAGE	63.9	48.7	7.3		9.8
		STANDARD DEVIATION	4.9	4.9	1.2		0.2

TABLE M11

COMPRESSION RESULTS AT $t/2$ LOCATION FOR
ALCOA 8090-T8771 "L" EXTRUSION

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)		
ARMY-MTL	RT	LONG	65.3	10.6		
			54.6	10.4		
			53.8	11.1		
			61.7	9.9		
			52.8	11.9		
			53.9	10.8		
MARTIN MARIETTA, LA	RT	LONG	49.8	11.5 (1)		
			43.4	(1)		
			50.0	11.9 (1)		
			54.1	11.9 (2)		
			47.9	11.8 (2)		
			47.7	11.8 (2)		
AVERAGE			52.9	11.2		
STANDARD DEVIATION			6.0	0.7		

(1): THICK SECTION
 (2): THIN SECTION

TABLE M12

COMPRESSION RESULTS AT $t/2$ LOCATION FOR
ALCOA 8090-T8771 "L" EXTRUSION

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)		
ARMY-MTL	RT	L TRANS	58.2	9.5		
			59.9	11.9		
			58.8	13.4		
			55.7	11.8		
			58.1	11.3		
			64.7	8.9		
MARTIN MARIETTA, LA	RT	L TRANS	52.0	11.9 (1)		
			49.8	11.7 (1)		
			49.8	11.8 (1)		
AVERAGE			56.3	11.4		
STANDARD DEVIATION			5.0	1.4		

(1): THICK SECTION

TABLE M13

COMPRESSION RESULTS AT $t/2$ LOCATION FOR
ALCOA 8090-T8771 "L" EXTRUSION

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)		
ARMY-MTL	RT	S TRANS	51.5	10.1		
			52.0	11.2		
			52.0	11.5		
MARTIN MARIETTA, LA	RT	S TRANS	50.1	11.7 (1)		
			50.2	11.8 (1)		
			50.1	11.4 (1)		
AVERAGE			51.0	11.3		
STANDARD DEVIATION			0.9	0.6		

(1): THICK SECTION

TABLE M14

RIVET SHEAR RESULTS FOR ALCOA
8090-T8771 "L" EXTRUSION

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
ARMY-MTL	LONG	40.7
		41.4
		45.0
		39.6
		41.4
		39.9
	AVERAGE	41.3
	STANDARD DEVIATION	2.3

TABLE M15

RIVET SHEAR RESULTS FOR ALCOA
8090-T8771 "L" EXTRUSION

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
ARMY-MTL	L TRANS	38.3
		37.5
		35.5
		38.7
		38.0
		36.8
	AVERAGE	37.5
	STANDARD DEVIATION	1.4

TABLE M16
FRACTURE TOUGHNESS RESULTS FOR
ALCOA 8090-T8771 "L" EXTRUSION

COMPANY	ORIENTATION	KIC (KSI in ^{0.5})	Kq (KSI in ^{0.5})	COMMENT
ARMY-MTL	L-T		31.9	(1)
			32.9	(1)
			30.2	(1)
			29.0	(1)
MARTIN MARIETTA, LA	L-T		33.1	(1)
			38.5	(1)
		36.3		
	AVERAGE	36.3	32.6	
	STANDARD DEVIATION		3.3	

(1): INVALID DUE TO B < 2.5(KQ/Fty)²

TABLE M17

FRACTURE TOUGHNESS RESULTS FOR
ALCOA 8090-T8771 "L" EXTRUSION

COMPANY	ORIENTATION	KIC (KSI in ^{0.5})	Kq (KSI in ^{0.5})	COMMENT
ARMY-MTL	T-L		29.8	(1),(2)
			28.9	(1),(2)
			30.8	(1),(2)
			30.2	(1),(2)
			30.9	(1),(2)
MARTIN MARIETTA, LA	T-L	20.2 19.7 18.0		
	AVERAGE	19.3	30.1	
	STANDARD DEVIATION	1.2	0.8	

(1): INVALID DUE TO P_{max}/P_q > 1.10

(2): INVALID DUE TO B < 2.5(K_Q/F_{Ty})²

TABLE M18

FRACTURE TOUGHNESS RESULTS FOR
ALCOA 8090-T8771 "L" EXTRUSION

COMPANY	ORIENTATION	KIC (KSI in ^{0.5})	Kq (KSI in ^{0.5})	COMMENT
ARMY-MTL	S-L	22.6 22.6 22.7 22.4 22.3 21.5		
	AVERAGE	22.4		
	STANDARD DEVIATION	0.4		

TABLE M19

FRACTURE TOUGHNESS RESULTS FOR
ALCOA 8090-T8771 "L" EXTRUSION

COMPANY	ORIENTATION	KIC (KSI in ^{0.5})	Kq (KSI in ^{0.5})	COMMENT
MARTIN MARIETTA, LA.	S-T	19.2 21.7 20.9		(1) (1)
	AVERAGE	20.9	20.5	
	STANDARD DEVIATION		1.8	

(1): INVALID DUE TO P_{max}/P_q > 1.10

TABLE M20

FATIGUE RESULTS WITH R=0.1 AND Kt=1.0 FOR
ALCOA 8090-T8771 "L" EXTRUSION

COMPANY	ORIENTATION	STRESS (KSI)	CYCLES
<hr/>			
ARMY-MTL	LONG	47.5	30,000
		39.3	164,000
		30.1	1,411,000
		28.0	3,639,000
		27.8	171,000
		27.5	11,787,000 *
		26.2	10,382,000 *

(*): RUN OUT

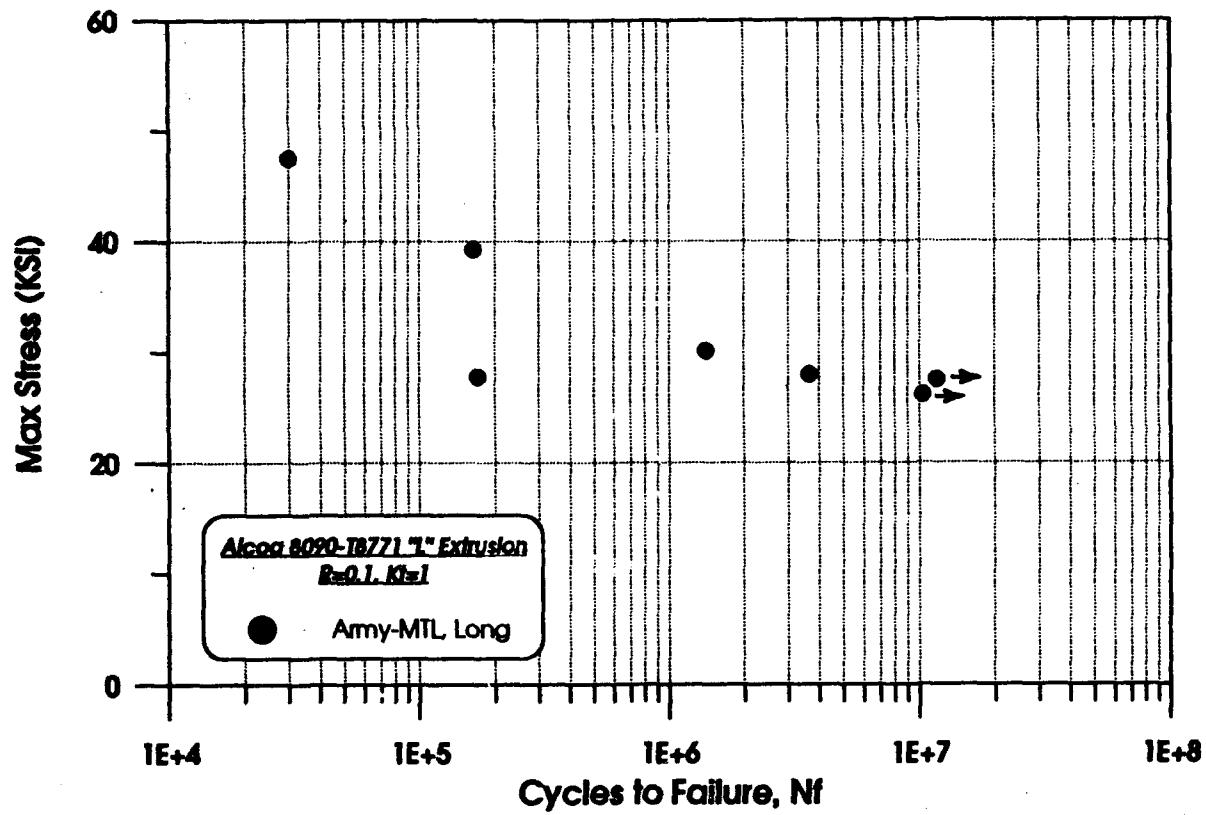


FIGURE M3. FATIGUE RESULTS FOR 8090-T8 771
L-EXTRUSION (R=0.1 AND Kt=1.0).
Army.

Fatigue Crack Growth Rate for 8090-T8
Extrusion, L-T Orientation

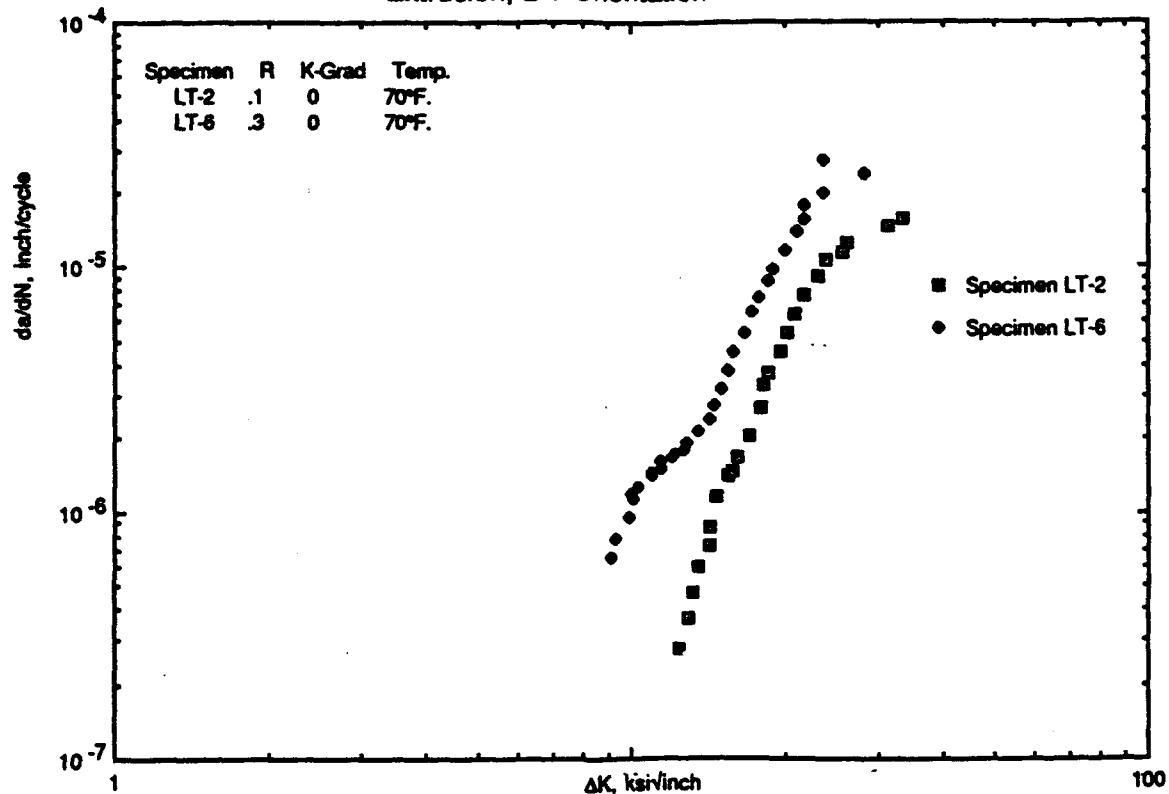


FIGURE M4. FATIGUE CRACK GROWTH RATES for
8090-T8771 L-Extrusion (L-T Orientation).
Martin Marietta.

TABLE M21
FATIGUE CRACK GROWTH RATE DATA ASSOCIATED WITH FIGURE M4
(Specimen P-411-LT-2)

Operator:	CPM	K Gradient:	0	
Sample date:	7/20/92	Min Load:	105 lbs.	
Material:	8080-T8 Al-Li	Max Load:	1050 lbs.	
ID #:	P-411-LT-2	Test Mode:	1	
Yield Strength	69,089 psi	Data Pt Inv:	0.01 inch	
Modulus of Elasticity	11,283,333 psi	Min Growth Rat	0.000001 inch	
COD Pos:	2	Compl Slope:	2	
Crack Plane:	LT	Pts/Cycle:	200	
Geometry:	1	Upper Slope Limit	85	
Width:	1.1987	Lower Slope Limit	15	
Thickness:	0.5905	No of Slopes Ave.	5	
Half span (MT)	0	Compliance Correction	1.21449	
Environment:	AIR	Notch Length:	0.4757 inch	
Temperature:	69	Precrack Length:	0.5256 inch	
Humidity:	72	Precrack Cycle	552511	
Waveform:	1	Precrack Max Load	1206.64 lbs.	
Test Frequency	30	Precrack Min Load	120.819 lbs.	
Test Type:	1	#Points:	33	
Cycles	Crack Length, inch	dK/dN, inch/cycle	dK, psi sqrt inch	Delta Load, lbs.
85101	0.5256	0	0	948.217
132924	0.5350	0	0	949.682
178420	0.5459	0	0	955.056
190090	0.5560	2.74E-07	12372	947.24
250515	0.5666	3.64E-07	12968	945.286
280660	0.5784	4.68E-07	13258	952.125
305150	0.5895	6.02E-07	13624	949.194
323275	0.6000	7.27E-07	14159	957.01
336375	0.6101	8.74E-07	14328	947.24
347470	0.6205	1.16E-06	14815	951.637
358560	0.6320	1.41E-06	15450	957.01
361625	0.6417	1.49E-06	15800	955.056
370025	0.6581	1.68E-06	16176	954.079
379780	0.6691	2.06E-06	17061	955.056
386620	0.6794	2.70E-06	17883	950.941
389570	0.6911	3.33E-06	18187	954.079
391950	0.7015	3.77E-06	18612	953.591
395340	0.7130	4.58E-06	19617	950.453
397385	0.7230	5.48E-06	20136	957.01
399430	0.7327	6.50E-06	20929	957.499
401145	0.7449	7.65E-06	21847	962.872
402655	0.7600	9.15E-06	23123	959.941
404565	0.7750	1.07E-05	23936	966.712
405610	0.7874	1.16E-05	25650	965.804
406650	0.8012	1.25E-05	26205	967.758
407690	0.8146	1.48E-05	31389	965.315
408735	0.8281	1.58E-05	33285	977.528
409780	0.8441	0	0	979.971
410155	0.8558	0	0	979.482
410885	0.8707	0	0	980.948
411240	0.8812	0	0	988.276
411610	0.8971	0	0	996.58
411985	0.9215	0	0	987.298

Final Cycle: 412200

Last Count: 1

Last Count 2: 1

Span: 100

Mean: 0

dA/dN method: 2

Poly points: 7

Start max Id: 1050.32 lbs.

Start max Kc: 13570.1 psi sqrt inch

Notes:

Tests were performed with the "CGR Crack Growth Program" from Interlaken Version 1.54.

The crack lengths were corrected based on the final measurements.

The data was averaged using the 7 point polynomial method.

The precrack Pmax load of 1207 lbs. resulted in a data 13% higher than the initial Pmax test load of 1050 lbs. did.

TABLE M22
FATIGUE CRACK GROWTH RATE DATA ASSOCIATED WITH FIGURE M4
(Specimen P-411-LT-6)

Operator:	cpm	K Gradient:	0	
Sample date:	7/20/92	Min Load:	315 lbs.	
Material:	8080-T8 Al-Li	Max Load:	1050 lbs.	
ID #:	P-411-LT-6	Test Mode:	1	
Yield Strength:	69,000 psi	Data Pt Intvl:	0.01 inch	
Modulus of Elast:	11,263,333 psi	Min Growth Rate:	0.000001 inch	
COO Pos:	2	Compl Slope:	2	
Crack Plane:	LT	Pts/Cycle:	200	
Geometry:	1	Upper Slope Limit:	65	
Width:	1.2006 inch	Lower Slope Limit:	15	
Thickness:	0.5993 inch	No of Slopes Ave:	1	
Half span (MT):	0	Compliance Corr.:	1.08217	
Environment:	AIR	Notch Length:	0.4821 inch	
Temperature:	70 deg. F.	Precrack Length:	0.5403 inch	
Humidity:	72%	Precrack Cycles:	507120	
Waveform:	1	Precrack Max Load:	1106.5 lbs.	
Test Frequency:	30 Hz	Precrack Min Load:	327.308 lbs.	
Test Type:	1	#Points:	42	
Cycles	Crack Length, inch	dΔN, inch/cycle	dK, psi sqrt inch	Delta Load, lbs.
103	0.485	0	0	740.107
36166	0.494	0	0	752.32
58310	0.503	0	0	735.222
81005	0.514	0	0	740.107
100185	0.524	8.52E-07	9107	742.55
113915	0.538	7.74E-07	8330	744.993
135260	0.547	9.59E-07	9852	754.783
148590	0.557	1.14E-06	10082	749.878
151025	0.570	1.19E-06	9997	737.866
157295	0.579	1.27E-06	10343	749.878
168220	0.588	1.40E-06	10993	764.533
173375	0.600	1.48E-06	11020	752.32
181490	0.609	1.51E-06	11372	754.783
187530	0.620	1.62E-06	11498	744.993
194930	0.630	1.70E-06	12085	754.783
198720	0.639	1.71E-06	12191	749.878
204275	0.648	1.82E-06	12858	757.206
209510	0.660	1.92E-06	12864	749.878
217715	0.672	2.17E-06	13531	752.32
222070	0.681	2.42E-06	14216	769.419
225625	0.691	2.77E-06	14485	784.533
228555	0.700	3.21E-06	15068	774.304
232250	0.710	3.83E-06	15457	766.976
235010	0.719	4.55E-06	15893	762.091
237200	0.730	5.45E-06	16734	776.746
239155	0.741	6.57E-06	17245	771.861
240470	0.750	7.48E-06	17702	769.419
241940	0.760	8.77E-06	18571	774.304
242775	0.769	9.93E-06	18948	771.861
243925	0.781	1.18E-05	19924	774.304
244835	0.790	1.39E-05	21135	786.517
245505	0.799	1.57E-05	21593	786.517
246195	0.811	1.80E-05	21730	784.074
246710	0.821	2.01E-05	23694	788.959
247305	0.834	2.39E-05	28121	788.959
247820	0.845	2.70E-05	23738	801.172
248170	0.854	3.22E-05	41777	796.287
248525	0.866	0	0	793.845
248880	0.878	0	0	793.845
249155	0.892	0	0	808.5
249350	0.905	0	0	808.5
249465	0.918	0	0	813.385

Final Cycle: 249,555

Last Count: 43

Last Count 2: 1

Span: 100

Mean: 0

dA/dN method: 1

Poly points: 9

Start max load: 1052.78 lbs.

Start max K: 13,489 psi sqrt inch

Notes:

Tests were performed with the "CGR Crack Growth Program" from Intertek, Rev. 1.54

The crack lengths were corrected based on the final measurements.

The data was averaged using the 9 point polynomial method.

Fatigue Crack Growth Rate for 8090-T8
Extrusion, T-L Orientation

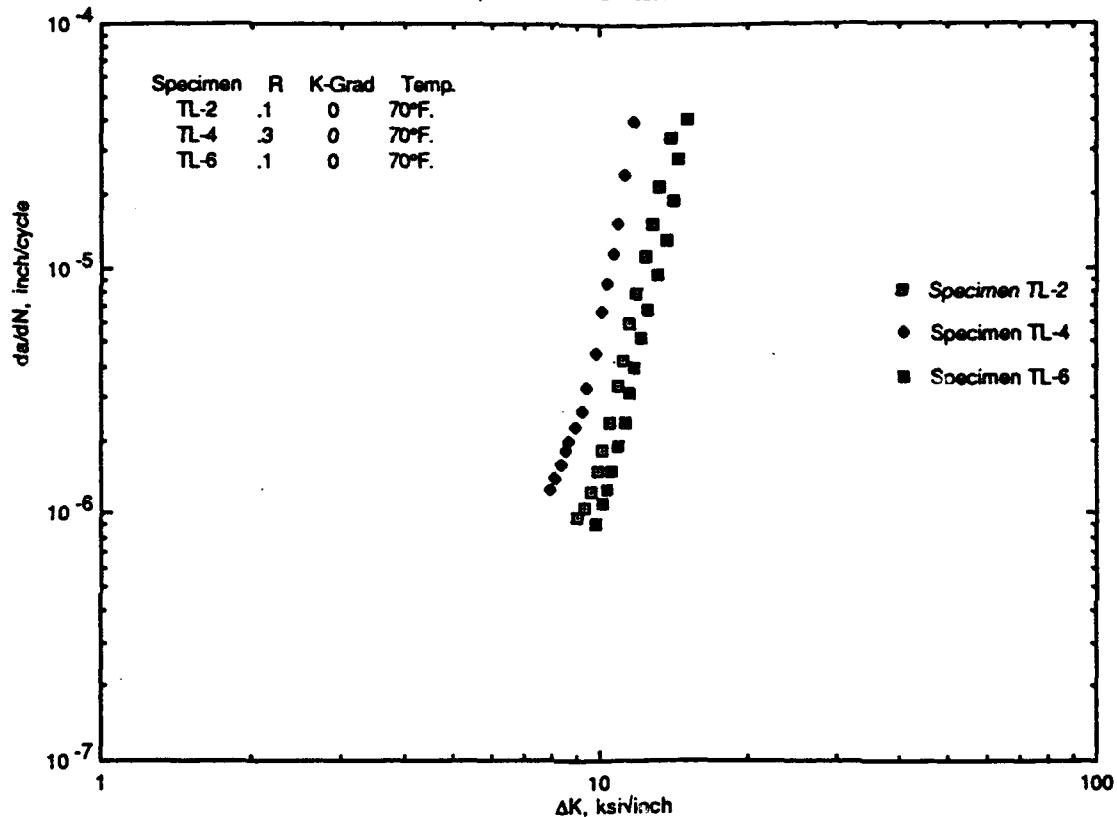


FIGURE M5. FATIGUE CRACK GROWTH RATES for
8090-T8771 L-EXTRUSION
(T-L Orientation).
MARTIN MARIETTA.

TABLE M23
FATIGUE CRACK GROWTH RATE DATA ASSOCIATED WITH FIGURE M5
(Specimen P-411-TL-2)

Operator:	cpm	K Gradient:	0	
Sample date:	7/20/92	Min Load:	90 lbs.	
Material:	8090-T8 Al-Li	Max Load:	900 lbs.	
ID #:	P-411-TL-2	Test Mode:	1	
Yield Strength:	55,209 psi	Data Pt Intvl:	0.01 inch	
Modulus of Elast:	9,263,333 psi	Min Growth Rate:	0.000001 inch	
COD Pos:	2	Compl Slope:	2	
Crack Plane:	TL	Pts/Cycle:	200	
Geometry:	1	Upper Slope Limit:	85	
Width:	1.1998 inch	Lower Slope Limit:	15	
Thickness:	0.5993 inch	No of Slopes Ave:	1	
Half span (MT):	0	Compliance Cor.:	23.0314	
Environment:	AIR	Notch Length:	0.481 inch	
Temperature:	71 deg. F.	Precrack Length:	0.542 inch	
Humidity:	73%	Precrack Cycles:	232012	
Waveform:	1	Precrack Max Load:	879.336 lbs.	
Test Frequency:	30 Hz	Precrack Min Load:	75.7206 lbs.	
Test Type:	1	#Points:	20	
Cycles	Crack Length, inch	dA/dN, inch/cycle	dK, psi sqrt inch	Delta Load, lbs.
102	0.4323	0	0	825.598
2593	0.4435	0	0	835.369
20719	0.4556	0	0	842.697
34715	0.4676	9.58E-07	9022	835.369
47520	0.4795	1.06E-06	9336	842.697
57690	0.4906	1.23E-06	9566	842.697
68185	0.5025	1.48E-06	9912	847.582
75330	0.5146	1.83E-06	10095	842.697
81600	0.5256	2.38E-06	10430	847.582
87780	0.5384	3.37E-06	10851	850.024
90445	0.5497	4.20E-06	11128	854.91
93675	0.5637	5.98E-06	11484	850.024
95480	0.5753	8.03E-06	11901	859.795
97165	0.5861	1.13E-05	12369	862.237
96235	0.5999	1.52E-05	12840	869.565
99145	0.6152	2.17E-05	13186	859.795
99895	0.6300	3.47E-05	13932	864.68
100400	0.6440	0	0	872.008
100590	0.6592	0	0	879.336
100780	0.6810	0	0	884.221
Final Cycle:	100820			
Last Count:	21			
Last Count 2:	21			
Span:	100			
Mean:	0			
dA/dN method:	1			
Poly points:	7			
Start max Id:	906.24 lbs.			
Start max k:	8539.27 psi sqrt inch			
Notes:				

Tests were performed with the 'CGR Crack Growth Program' from Interlaken, Rev. 1.54
The crack lengths were corrected based on the final measurements.
The data was averaged using the 7 point polynomial method.

TABLE M24
FATIGUE CRACK GROWTH RATE DATA ASSOCIATED WITH FIGURE MS
(Specimen P-411-TL-4)

Operator:	cpm	K Gradient:	0	
Sample date:	7/20/92	Min Load:	270 lbs.	
Material:	8090-T8 Al-Li	Max Load:	500 lbs.	
ID #:	P-411-TL-4	Test Mode:	1	
Yield Strength	55209 psi	Data Pt Intvl:	0.01 inch	
Modulus of Elasticity	9,263,333 psi	Min Growth Rate:	0.000001 inch	
COD Position:	2	Compl Slope:	2	
Crack Plane:	TL	Pts/Cycle:	200	
Geometry:	1	Upper Slope Limit:	85	
Width:	1.198 inch	Lower Slope Limit:	15	
Thickness:	0.5983 inch	No of Slopes Ave:	1	
Half span (MT)	0	Compliance Cor.:	1.04518	
Environment:	AIR	Notch Length:	0.4788 inch	
Temperature:	70 degrees F.	Precrack Length:	0.540 inch	
Humidity:	72%	Precrack Cycles:	161228	
Waveform:	1	Precrack Max Load:	889.106 inch	
Test Frequency	30 Hz	Precrack Min Load:	236.932 inch	
Test Type:	1	#Points:	21	
Cycles	Crack Length, inch	dA/dN, inch/cycle	dK, psi sqrt inch	Delta Load, lbs.
102	0.477122	0	0	666.83
8084	0.486919	0	0	661.944
17911	0.496762	0	0	664.357
26545	0.506321	1.24E-06	7908.28	669.272
34068	0.515525	1.40E-06	8103.03	671.715
40796	0.52494	1.60E-06	8284.49	671.715
46567	0.534579	1.80E-06	8532.1	676.6
51145	0.544001	2.00E-06	8642.17	671.715
55880	0.553252	2.27E-06	8911.49	676.6
60615	0.563792	2.65E-06	9217.21	681.485
63995	0.573166	3.30E-06	9352.74	676.6
67615	0.584118	4.57E-06	9760.35	683.928
69880	0.593493	6.68E-06	10104.7	688.813
70945	0.603432	8.70E-06	10314.4	691.255
72170	0.612938	1.16E-05	10651.5	693.698
72835	0.622871	1.52E-05	10873.5	693.698
73740	0.63399	2.43E-05	11343.3	693.698
74170	0.643239	4.02E-05	11815.2	701.026
74440	0.656417	0	0	701.026
74625	0.668738	0	0	703.468
74735	0.68147	0	0	713.239
Final Cycle:	74735			
Last Count:	22			
Last Count 2:	1			
Span:	100			
Mean:	0			
dA/dN method:	2			
Poly points:	7			
Start max Kt:	920.86			
Start max Kt:	11229			
Notes:				

Tests were performed with the "CGR Crack Growth Program" from Interlaken Version 1.54.

The crack lengths were corrected based on the final measurements.

The data was averaged using the 7 point polynomial method.

TABLE M25
FATIGUE CRACK GROWTH RATE DATA ASSOCIATED WITH FIGURE M5
(Specimen P-411-TL)

Operator:	cpm	K Gradient:	0	
Sample date:	7/20/92	Min Load:	90	
Material:	8080-T8	Max Load:	900	
ID #:	P-411-TL	Test Mode:	1	
Yield Strength:	55,209 psi	Data Pt Intvl:	0.01 inch	
Modulus of Elast:	9,263,333 psi	Min Growth Rate:	0.000001 inch	
COD Pos:	2	Compl Slope:	2	
Crack Plane:	TL	Pts/Cycle:	200	
Geometry:	1	Upper Slope Limit:	85	
Width:	1.197 inch	Lower Slope Limit:	15	
Thickness:	0.5995 inch	No of Slopes Ave:	3	
Half span (MT):	0	Compliance Cor.:	1.11667	
Environment:	AIR	Notch Length:	0.477 inch	
Temperature:	70 deg. F.	Precrack Length:	0.540 inch	
Humidity:	72%	Precrack Cycles:	271,514	
Waveform:	1	Precrack Max Load:	881.8 lbs.	
Test Frequency:	30 Hz	Precrack Min Load:	68.4 lbs.	
Test Type:	1	#Points:	21	
Cycles	Crack Length, inch	dA/dN, inch/cycle	dK, psi sqrt inch	Delta Load, lbs.
197	0.472871	0	0	836.183
26854	0.482567	0	0	838.626
38197	0.493092	0	0	840.254
46238	0.502636	9.03E-07	9757	838.626
59160	0.512279	1.10E-06	10100	841.882
67025	0.521875	1.26E-06	10300	842.697
75245	0.531116	1.50E-06	10612	847.582
82420	0.543787	1.90E-06	10857	844.325
88200	0.553981	2.35E-06	11172	845.953
93110	0.564713	3.10E-06	11544	848.396
95925	0.576006	3.97E-06	11799	850.024
99285	0.586188	5.33E-06	12232	850.839
101210	0.59915	6.88E-06	12581	852.467
103155	0.612628	9.47E-06	13117	856.538
104405	0.623243	1.32E-05	13605	858.166
105130	0.634197	1.91E-05	14086	865.494
105880	0.643813	2.60E-05	14430	860.809
106055	0.655555	4.07E-05	15019	869.565
106260	0.665858	0	0	865.494
106465	0.675114	0	0	867.123
106665	0.69	0	0	878.079
Final Cycle:	106,725			
Last Count:	22			
Last Count 2:	1			
Span:	100			
Mean:	0			
dA/dN method:	1			
Poly points:	7			
Start max Id:	911.1 lbs.			
Start max k:	10943.8 psi sqrt inch			
Notes:				

Tests were performed with the 'CGR Crack Growth Program' from Interlaken, Rev. 1.54
The crack lengths were corrected based on the final measurements.
The data was averaged using the 7 point polynomial method.

Fatigue Crack Growth Rate for 8090-T8
Extrusion, S-T Orientation

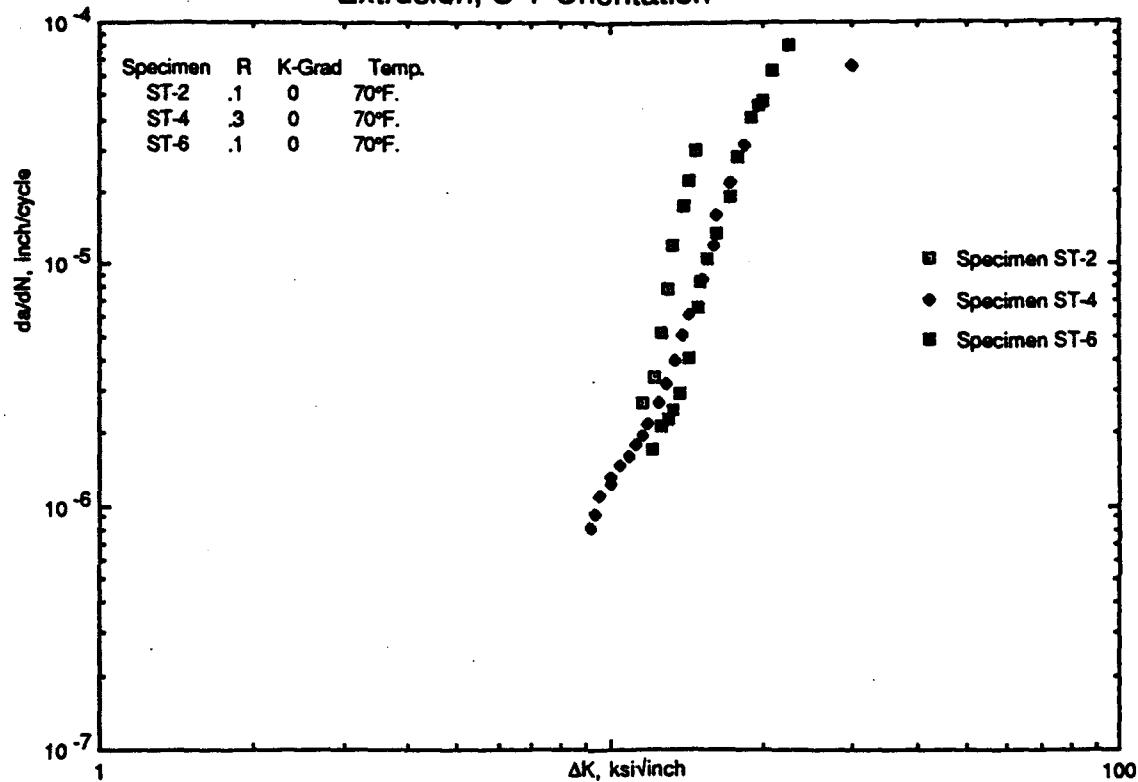


FIGURE M6. FATIGUE CRACK GROWTH RATES for
8090-T8771 L-EXTRUSION
(S-T Orientation).
MARTIN MARIETTA.

TABLE M26
FATIGUE CRACK GROWTH RATE DATA ASSOCIATED WITH FIGURE M6
(Specimen P-411-ST-2)

Operator:	cpm	K Gradient:	0	
Sample date:	7/20/92	Min Load:	100 lbs.	
Material:	8000-T8 Al-Li	Max Load:	1000 lbs.	
ID #:	P-411-ST-2	Test Mode:	1	
Yield Strength:	65,209 psi	Data Pt Intvl:	0.01 inch	
Modulus of Elast:	9,263,333 psi	Min Growth Rate:	0.000001 inch	
COD Pos:	2	Compl Slope:	2	
Crack Plane:	ST	Pts/Cycle:	200	
Geometry:	1	Upper Slope Limit:	85	
Width:	1.2012 inch	Lower Slope Limit:	15	
Thickness:	0.5967 inch	No of Slopes Ave:	5	
Half span (MT):	0	Compliance Cor.:	1.1205	
Environment:	AIR	Notch Length:	0.4817 inch	
Temperature:	72 deg. F.	Precrack Length:	0.550 inch	
Humidity:	70%	Precrack Cycles:	unrecorded	
Waveform:	1	Precrack Max Load:	1070.7 lbs.	
Test Frequency:	30 Hz	Precrack Min Load:	107.0 lbs.	
Test Type:	1	#Points:	14	
Cycles	Crack Length, inch	dK/dN, inch/cycle	dK, psi sqrt inch	Delta Load, lbs.
291	0.507021	0	0	919.394
6500	0.51871	0	0	915.486
11636	0.532583	0	0	915.486
15698	0.545582	2.66E-06	11722	917.929
22717	0.559751	3.42E-06	12255	914.998
26777	0.571909	5.21E-06	12724	917.44
28956	0.584801	7.94E-06	13149	918.417
30058	0.596039	1.19E-05	13337	913.043
31158	0.606355	1.78E-05	13972	923.302
31720	0.620262	2.22E-05	14321	924.279
32287	0.631771	3.00E-05	14840	926.234
32851	0.650231	0	0	924.768
33419	0.669072	0	0	924.768
33716	0.6837	0	0	931.119
Final Cycle:	33957			
Last Count:	15			
Last Count 2:	1			
Span:	100			
Mean:	0			
dAdN method:	1			
Poly points:	7			
Start max load:	1008.35 lbs.			
Start max K:	10501.5 psi sqrt inch			
Notes:				

Tests were performed with the "CGR Crack Growth Program" from Interlaken, Rev. 1.54

The crack lengths were corrected based on the final measurements.

The data was averaged using the 7 point polynomial method.

The precrack Pmax load of 1071 lbs. resulted in a delta 7% higher than the initial Pmax test load of 1000 lbs. did.

TABLE M27

FATIGUE CRACK GROWTH RATE DATA ASSOCIATED WITH FIGURE M6
(Specimen P-411-ST-4)

Operator:	cpm	K Gradient:	0	
Sample date:	7/20/92	Min Load:	270 lbs.	
Material:	8090-T8 Al-Li	Max Load:	900 lbs.	
ID #:	P-411-ST-4	Test Mode:	1	
Yield Strength:	55,209 psi	Data Pt Intvl:	0.01 inch	
Modulus of Elast:	9,263,333 psi	Min Growth Rate:	0.000001 inch	
COD Pos:	2	Compl Slope:	2	
Crack Plane:	ST	Pts/Cycle:	200	
Geometry:	1	Upper Slope Limit:	85	
Width:	1.200 inch	Lower Slope Limit:	15	
Thickness:	0.5997 inch	No of Slopes Ave:	1	
Half span (MT):	0	Compliance Cor.:	0.640211	
Env:	AIR	Notch Length:	0.4795 inch	
Temp:	70 deg. F.	Precrack Length:	0.54 inch	
Humidity:	72%	Precrack Cycles:	180,566	
Waveform:	1	Precrack Max Load:	1038.1 lbs.	
Test Frequency:	30 Hz	Precrack Min Load:	300.44 lbs.	
Test Type:	1	#Points:	31	
Cycles	Crack Length, inch	dA/dN, inch/cycle	dK, psi sqrt inch	Delta Load, lbs.
204	0.535	0	0	644.846
1027	0.545	0	0	644.846
33151	0.556	0	0	647.269
59702	0.567	0	0	649.731
73082	0.577	8.18E-07	9060	652.174
84387	0.589	9.32E-07	9256	649.731
96972	0.600	1.10E-06	9541	649.731
109162	0.611	1.24E-06	9882	654.617
116227	0.624	1.33E-06	10141	649.731
124732	0.635	1.49E-06	10496	652.174
132042	0.647	1.61E-06	10913	657.059
141112	0.659	1.79E-06	11320	652.174
146817	0.670	1.97E-06	11847	652.174
150602	0.680	2.19E-06	11886	652.174
156782	0.691	2.67E-06	12497	657.059
160687	0.701	3.19E-06	12921	657.059
164677	0.712	3.99E-06	13517	661.944
167347	0.724	5.04E-06	13902	657.059
169057	0.735	6.21E-06	14443	664.387
171647	0.746	8.66E-06	15345	664.387
173037	0.757	1.21E-05	16059	664.387
173547	0.768	1.59E-05	16324	664.387
174372	0.778	2.16E-05	17294	660.272
175042	0.791	3.09E-05	18369	661.944
175472	0.806	4.60E-05	19061	676.6
175742	0.816	6.64E-06	20879	674.157
175937	0.829	0	0	676.6
176047	0.843	0	0	676.6
176157	0.856	0	0	683.828
176287	0.873	0	0	679.043
176382	0.891	0	0	681.485
Final Cycle:	176432			
Last Count:	32			
Last Count 2:	32			
Span:	100			
Mean:	0			
dA/dN method:	1			
Poly points:	9			
Start max ld:	908.647 lbs.			
Start max k:	11,168.7 psi sqrt inch			
Notes:				

Tests were performed with the "CGR Crack Growth Program" from Interlaken, Rev. 1.54

The crack lengths were corrected based on the final measurements.

The data was averaged using the 9 point polynomial method.

The precrack Pmax load of 1038 lbs. resulted in a delta 14.6% higher than the initial Pmax load of 909 lbs. did.

TABLE M28
FATIGUE CRACK GROWTH RATE DATA ASSOCIATED WITH FIGURE M6
(Specimen P-411-ST-6)

Operator:	cpm	K Gradient:	0	
Sample date:	7/20/92	Min Load:	94 lbs.	
Material:	8080-T8 Al-Li	Max Load:	940 lbs.	
ID #::	P-411-ST-6	Test Mode:	1	
Yield Strength:	55,209 psi	Data Pt Intvl:	0.01 inch	
Modulus of Elast:	9,253,333 psi	Min Growth Rate:	0.000001 inch/inch	
COD Pos:	2	Compl Slope:	2	
Crack Plane:	ST	Pts/Cycle:	200	
Geometry:	1	Upper Slope Limit:	85	
Width:	1.1902 inch	Lower Slope Limit:	15	
Thickness:	0.5907 inch	No of Slopes Ave:	1	
Half span (MT):	0	Compliance Corr.:	1.214	
Env:	AIR	Notch Length:	0.4782 inch	
Temp:	71 deg. F.	Precrack Length:	0.540 inch	
Humidity:	72%	Precrack Cycles:	208,233	
Waveform:	1	Precrack Max Load:	886.663 lbs.	
Test Frequency:	30 Hz	Precrack Min Load:	68.3926 lbs.	
Test Type:	1	#Points:	23	
Cycles	Crack Length, inch	dA/dN, inch/cycle	dK, psi sqrt inch	Delta Load, lbs.
103	0.546076	0	0	874.45
15442	0.556871	0	0	874.45
25448	0.567068	0	0	879.336
31625	0.577573	1.74E-06	12198	876.893
39313	0.590622	2.17E-06	12641	876.893
43733	0.602378	2.29E-06	13019	879.336
48073	0.613231	2.50E-06	13376	879.336
51940	0.623713	2.94E-06	13744	879.336
56995	0.634609	4.09E-06	14449	886.663
59660	0.644968	6.61E-06	14924	886.663
60905	0.656267	8.42E-06	15200	886.663
62190	0.668447	1.06E-05	15729	886.663
63180	0.682332	1.35E-05	16346	891.549
64330	0.692437	1.93E-05	17253	893.991
64915	0.703001	2.75E-05	17945	898.434
65505	0.72127	4.03E-05	19012	908.876
65690	0.73196	4.48E-05	19715	908.647
65800	0.742498	4.74E-05	19950	911.089
66225	0.757529	6.32E-05	21027	911.089
66415	0.770321	7.98E-05	22539	908.647
66605	0.781477	0	0	928.186
66715	0.800784	0	0	925.745
66825	0.812337	0	0	935.515
Final Cycle:	66900			
Last Count:	1			
Last Count 2:	0			
Span:	100			
Mean:	0			
dA/dN method:	1			
Poly points:	7			
Start max load:	9,555 lbs.			
Start max Kt:	12,313 psi sqrt inch			
Notes:				

Tests were performed with the "CGR Crack Growth Program" from Interlaken, Rev. 1.54
The crack lengths were corrected based on the final measurements.
The data was averaged using the 7 point polynomial method.